

# Final Technical Report

DFID Aquaculture Research Programme

Project R7100

*The Improved Management of Small-Scale Cage Culture in Asia*

## Prepared by

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***Executive Summary***

Project R7100, 'The improved management of small-scale cage culture in Asia' was concerned with examining the small-scale rapidly expanding cage culture industries in inland (Bangladesh) and coastal (Vietnam) systems. By identifying the technical, social, economic and institutional context of potential beneficiaries, the rural resource poor and women in particular, the suitability of cage culture as a livelihood strategy for these groups could be assessed. Knowledge created remains in the countries, where it can be best accessed by stakeholders.

The types of outputs offered as a result of this research therefore took two forms i) capacity building of institutions and stakeholders and ii) guidance on technology selection, refinement and management. Via an end of project workshop these have resulted in the formation of generic guidelines concerning the selection and extension of appropriate small-scale cage culture technologies. It is hoped that these will contribute towards the DFID development goal of a sustainable increase in yields from small-scale semi-intensive and extensive aquaculture systems. Due to the collaborative nature of project R7100 it is difficult to disentangle whether benefits to the rural poor are a direct result of the research, or the activities of partner institutions, or a combination of both. However it is likely that the research resulted in more rapid identification of cage technologies and dissemination of findings due to the utilisation of the built promotional framework.

***Project Purpose***

The purpose of project R700, 'The Improved Management of Small-Scale Cage Culture in Asia', is to develop sustained small-scale cage culture in inland and coastal waters in Asia. By the end of project, management strategies based on a thorough understanding of the social, institutional and resource environment of resource poor groups in two project locations, Bangladesh (inland waters) and Vietnam (coastal), would be identified and applied in selected locations or production systems. Collaboration was an important feature of the project. Working with NGOs in Bangladesh allowed for the utilisation of existing promotional networks. Working with a local University in Vietnam allowed us to draw on existing knowledge and experience while at the same time increasing research capacity. The participatory approach used in both Bangladesh and Vietnam was crucial to developing local understanding and research capacity.

The findings of the project were disseminated via working papers and workshop proceedings, press releases, presentation at national and international conferences, peer review publication in journals, production of extension materials and guidelines for small-scale cage culture.

## **1. Introduction**

A major constraint to the development of cage fish culture by poor communities is the lack of technologies appropriate to their technical, social, economic and institutional context. A 2-year DFID-funded Research Project, R7100 '*The Improved Management of Small-Scale Cage Culture in Asia*', was awarded to the Institute of Aquaculture (IoA), University of Stirling, and the Asian Institute of Technology (AIT), Bangkok, to address these issues (Table 1). Prior to Project R7100 the DFID aquaculture research program (ARP) had supported an MSc project from the Institute of Aquaculture, (IoA), University of Stirling, on the use of periphyton to enhance tilapia production in cages (Huchette 1997) The inter-institutional relationship was further developed through Project R7100. The project was collaborative (Table 1) and in both project locations capitalised on the *in-built promotional pathways* of the partner institutions, allowing for capacity building, more effective locally based participatory research methodologies, and rapid dissemination of information to beneficiaries.

The research approach in the two countries differed significantly. In Bangladesh research focused on developing and adapting small-scale cage culture technologies to meet farmer needs. In Vietnam a broader approach was taken. The project both sought to understand the livelihoods of poor coastal households through participatory rural appraisal and to characterise and assess a range of possible cage culture and other developments in terms of their suitability to meet the development needs and potential of poor households. It also examined the broader social, economic and environmental impacts of increased cage culture activity. Unlike the Bangladesh component, Vietnamese researchers did not intervene in current aquaculture or attempt to develop new technologies.

Cages have certain advantages over other aquaculture production systems in terms of uptake by rural poor and landless people (Beveridge 1996; Beveridge & Stewart, 1998). The integrity of the cage unit means that large, communal water bodies can be used and, crucially, the ability to culture fish is not reliant on the ownership or leasing



of land. Hence in theory where access to a water body can be secured, landless people can grow fish in cages in order to derive nutritional and economic benefits. In addition a problem often encountered in traditional pond aquaculture in Bangladesh is that of multiple ownership. Conflicts can arise when determining the ownership of the fish, resulting in under-utilisation of the water resource. In cage aquaculture the ownership issue is simple, in that the owners of the cages are the owners of the farm stock. Generally fish in cages do not escape, provided a top net is present and the cage remains undamaged; cages also exclude predators and the caged fish are easily managed and harvested. The culture of fish in cages can therefore be described as a promising technology already proven in many other Asian countries (Beveridge 1996; Beveridge and Stewart 1998; Beveridge and Muir 1999). There are, however, some negative characteristics. Cage culture utilises resources such as water, space, seed and feed, often in competition with other resource users. Wastes are released that may impact on the benthic and water column environments. Sustainable development requires assessment and monitoring to identify and minimise impacts.

Project R7100 was implemented to assess the potential of cage aquaculture for the rural resource poor in Bangladesh and Vietnam and to develop generic guidelines for small-scale cage culture development. The final report is structured around the three principal outputs of the project logical framework (Appendix I).

- ?? *Output 1*: the current status of small-scale cage aquaculture (Section 2);
- ?? *Output 2*: the technical, economic, social and institutional contexts of small-scale cage aquaculture (Section 3);
- ?? *Output 3*: planning and extension guidelines for small-scale cage aquaculture (Section 4).

In Sections 2 and 3 the issues surrounding cage culture (*Outputs 1* and *2*) in Bangladesh and Vietnam are considered independently. Information is synthesised in Section 4 (*Output 3*) in the form of generic guidelines. Each output conforms to the DFID technical report guidelines describing the activities, outputs and contributions the findings have made towards benefiting the rural resource poor.

**Table 1. Collaborating institutions, Project R7100**

	<b>Name</b>	<b>Type</b>	<b>Key Contact</b>	<b>Function</b>
Bangladesh	Institute of Aquaculture University of Stirling Stirling, UK	Academic institution	<i>Institute of Aquaculture</i> Malcolm Beveridge (Project Leader); Paul Bulcock (Research Assistant)	DFID funded development project benefiting the rural resource poor and women, by the implementation of small-scale cage technologies.
	CARE Bangladesh Dhaka Bangladesh	International NGO	<i>CARE CAGES Project</i> Kenneth McAndrew (Project Co-ordinator); Naseem Ahmed (Assistant Co- ordinator)	<i>Collaborating on:</i> ?? case studies to examine the technical, economical, social and institutional aspects of small-scale culture ?? technology identification and testing ?? participatory impact monitoring and evaluation ?? examination of researchable constraints ?? training of stakeholders
Vietnam	AIT Bangkok Thailand	Regional academic institutional	<i>AIT</i> John Hambrey <sup>1</sup> (Research Scientist)	Institutional development; access to local expertise; local research base

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	University of Fisheries Nha Trang Vietnam	National academic institution	<i>The University of Fisheries</i> Prof Nguyen Trong Nho (University Representative); Le Anh Tuan and Ta Khak Thoung (Project Officers)	<i>Collaborating on:</i> ?? An assessment of the costs and sustainability of seed supply to marine cage culture in Khanh Hoa province ?? Rapid appraisal of relevant institutions ?? Review of costs and sustainability of current and potential feed sources ?? Assessment of comparative economics, resource profiles and sustainability of alternative species
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## **2. Current status and characteristics of small scale cage aquaculture**

**Output 1 assesses the key issues with regard to small-scale cage culture and the rural resource poor in Bangladesh and Vietnam. Similarities and differences between locations are considered and research priorities identified.**

### **2.1 Background**

Cage aquaculture is common in central and south east Asia in countries such as China, Philippines, Indonesia and Thailand (Beveridge 1996, Beveridge & Stewart 1998). Throughout these regions a wide range of marine and freshwater species are cultured in cages including seabass (*Lates calcarifer*) (Rimmer & Russel 1998), grouper and snapper (Subfamily: *Epinephelinae*) (Seng 1998), tilapia (*Oreochromis* spp.), milkfish (*Chano chanos*) (Bagarinao 1998), *Pangassius*, Grass carp (*Ctenopharyngodon idella*) and many others. As far as can be determined, the origins of cage aquaculture date back two millennia or so to China (Beveridge & Little 2000). However, there is little documentary evidence of cage rearing of fishes until the end of the 19<sup>th</sup> century. In the Great Lake area of Cambodia, floating cages have been used for more than 100 years while in Indonesia both floating and anchored cages have been in use since the 1940s. 'Traditional' small-scale cage culture activities may be distinguished from the intensive cage production systems by their reliance on natural construction materials and low levels of feed inputs. 'Modern', intensive cage aquaculture typified by the use of synthetic, manufactured materials and commercial feed inputs first appeared in Japan with the culture of yellowtail (*Seriola quinqueradiata*) in the 1950s. Atlantic salmon (*Salmo salar*) was first cultured in Norway a decade or so later while tilapia cage culture originated in the USA during the late 1960s (Beveridge 1996).

### **2.2 Activities**

In accordance with the project logical framework (Appendix I) to define the context, key parameters and performance indicators of small-scale cage culture as a mechanism by which to benefit to the rural poor, a multidisciplinary literature review was conducted at both project locations. Diverse sources and types of information

were used, including project documents, interviews with relevant stakeholders, project staff, government departments and NGOs.

### **2.3 Bangladesh**

Owing to the recent decline in capture fisheries, a prominent livelihood of the rural resource poor (Toufique 1997), and an increase in the demand for fish protein there is considerable potential in Bangladesh for aquaculture expansion (Lewis & Gregory 1991). Traditional aquaculture (see Figure 1), has focused on pond systems, which necessitates the ownership or lease of a pond or water body, thereby excluding the landless and rural resource poor. Although it has had a brief and mostly unsuccessful history in Bangladesh (Ireland 1999), cage culture can alleviate these constraints. Previous attempts at introducing the technology in Bangladesh have failed primarily due to the inappropriate transfer of technology from other regions (Ireland 1999). A consideration of the technical, economic, social and institutional context of the rural poor is required if cage aquaculture is to be successfully promoted. It is also important to recognise the presence of competing demands upon labour and capital as farmers and households manage a portfolio of interests (Ireland 1999, Lewis et al 1996). The uptake of a new activity such as cage aquaculture by rural households is therefore considered carefully prior to implementation, as it may necessitate a reallocation of resources and time within the household. The impact can be particularly important to the women within the household who may bear the brunt of adverse effects, such as an increase in workload. Equally important is the impact cage implementation has upon the community and other resource use as conflicts and jealousy may arise from the expansion of these systems (Ireland 1999).

Small-scale cage aquaculture must be a low input technology with low economic and opportunity costs. Availability and ease of access to resources is therefore crucial in governing the type of production system. Key factors include consideration of the most appropriate type and source of cage materials and especially the lack of access to quality sources of seed and feed that are thought to be major constraints to cage aquaculture development.

The successful adoption of cage aquaculture technologies by the rural resource poor in Bangladesh rests upon an understanding of the technical, economic, social and institutional contexts of beneficiaries. Past cage initiatives have tended to neglect this, concentrating on the wholesale replication of technology packages from other regions. Research too has followed a narrow disciplinary approach. Taking a holistic, systems-based approach and liaising with partner NGOs and beneficiaries is likely to prove more successful in achieving sustained development of small-scale cage culture in Bangladesh. This is the approach adopted by the CARE CAGES (Cage Aquaculture for Greater Economic Success) project. It is particularly concerned that cage aquaculture development benefits the rural resource poor and women. Cages are supplied by the CAGES project and distributed via collaborative Non Governmental Organisations (NGOs). The project has met with increasing success, production increasing from an initial 9948 tonnes (357 households) in 1997 to 51,618 tonnes (2113 households) in 1999. Production is expected to further rise to 76,000 tonnes in 2000. (Figure 2) (CARE 1999).

#### **2.4 Vietnam**

Cage culture is much more developed in Vietnam. Significant activity started in the Mekong Delta in the 1960s, and rapid expansion took place in the early 1990s with the appearance of marine cage culture. The major cultured species are: catfishes (*Pangasius bocourti*, *P. hypophthalmus* and *P. micronemus* Bleeker; *Clarias macrocephalus* and *C. gariepinus*), lobsters (*Panulirus ornatus*, *P. hormarus*, *P. timpsoni*, and *P. longipes*), groupers (*Epinephelus bleekeri*, *E. akaara*, *E. sexfasciatus*, *E. malabaricus*, *E. coioides*, *E. merra* and *Cephalopholis miniata*). Yellowtail (*Seriola dumerili*) is also cultured in smaller quantities. In 1998 there were roughly 18,000 cages, of which 6,000 were located in coastal waters, mainly in Nha Trang Bay in the South, and Ha Long Bay in the North. In most cases a single family or household owns one or two medium sized fixed (hanging) or floating cages, each of around 30m<sup>3</sup>. Some state enterprises run somewhat larger operations. Sea pens are also used for culture of various species (penaeid shrimps, groupers, rabbitfish, etc.) in Tam Giang lagoon (Thua Thien - Hue province). Together, these marine cages and

pens yielded 540 tonnes of fish and shellfish valued at more than VND100 billion (ca US \$7.2 million) in 1998.

There is significant potential for further expansion of cage aquaculture in terms of area and species. There are approximately 250,000 ha of sheltered seawaters, including creeks, bays, and lagoons, suitable for cage culture. Quang Ninh-Hai Phong region (Ha Long bay region) and Thua Thien Hue-Binh Thuan region (Southern Central region) are particularly suitable in terms of natural conditions. Species which are not currently cultured commercially, but which have potential and are under investigation include Black king fish *Rachycentron canadum*, sea bass *Lates calcarifer*, Sea horses *Hippocampus spp*, Scallop *Chlamys nobilis*, and Abalone *Haliotis sp*.

The rapid expansion of cage culture to date has been driven by profitability rather than research and extension. Most of the technology development has been farmer led. By 1994 however the Vietnam government, particularly the MoF (Ministry of Fisheries), considered marine cage culture as important technology, and introduced the Program of Cage Aquaculture, as part of its national policy on fisheries sector development. This policy sets a target of a total of 2 million tonnes of aquaculture products with an export value of \$2.5 billion, by the year 2010.

The main concerns regarding marine cage culture in Vietnam, especially given these ambitious targets, are the sustainability of seed and feed supply, environmental impact, and the impact of development in terms of poverty alleviation. Culture of the main species groups – grouper and lobster – depends entirely upon the collection of wild seed. It is likely that this will have a significant impact on the capture fishery, while at the same time constraining expansion of aquaculture. Production of both groups also depends on the use of so called “trash fish” for feeding. The impacts of demand for trash fish on the sustainability of capture fisheries, and on the price of fish to the poor, are unclear.

## **2.5 Summary**

These brief reviews demonstrate the range of issues facing the development of small-scale culture in Asia. Despite the differences between the two countries, a lack of knowledge of the range of alternatives, and the social, economic and environmental characteristics of specific technologies were perceived as significant constraints, as was uncertainty of success when compared to the more traditional livelihood strategies.

Lack of availability of high quality feed and seed at a reasonable cost were critical for the poorest in both countries. In Bangladesh access to land or water resources was a significant issue, although this was much less so in Vietnam. In Vietnam a lack of access to credit was perceived as crucial, whilst in Bangladesh the CAGES project removed this constraint, by providing linkages with institutions that provide credit. Indeed, the wide availability of micro-credit from NGOs to even the poorest households in Bangladesh contrasted with the situation in Vietnam, where lack of title to land or water resources, which might serve as loan collateral, effectively precluded the poorest households from obtaining credit. However other constraints were more serious in Bangladesh, including poaching, floods and the inability of women to fully participate due to cultural/religious norms.

## **2.6 Contribution of Outputs**

The literature reviews were conducted in order to identify and define the context, key parameters and performance indicators of small-scale cage culture in two locations in Asia. From these it has become apparent that research should concentrate on the technical, social, economic and institutional context of intended beneficiaries in order to select, adapt and refine small-scale cage culture technology. Although there are similarities, the differences between project locations demonstrate the clear need for a locally based and participatory approach to research and development, allowing for the collaborative development of farmer and utilisation of NGO and researcher skills and awareness.



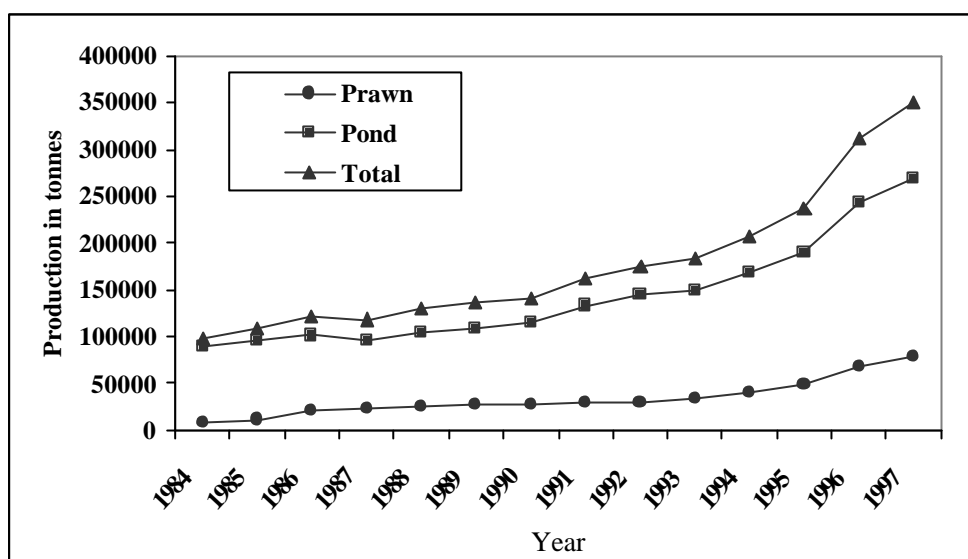


Figure 1. Aquaculture production in Bangladesh pond and prawn farms. Source, Department of Fisheries, Bangladesh.

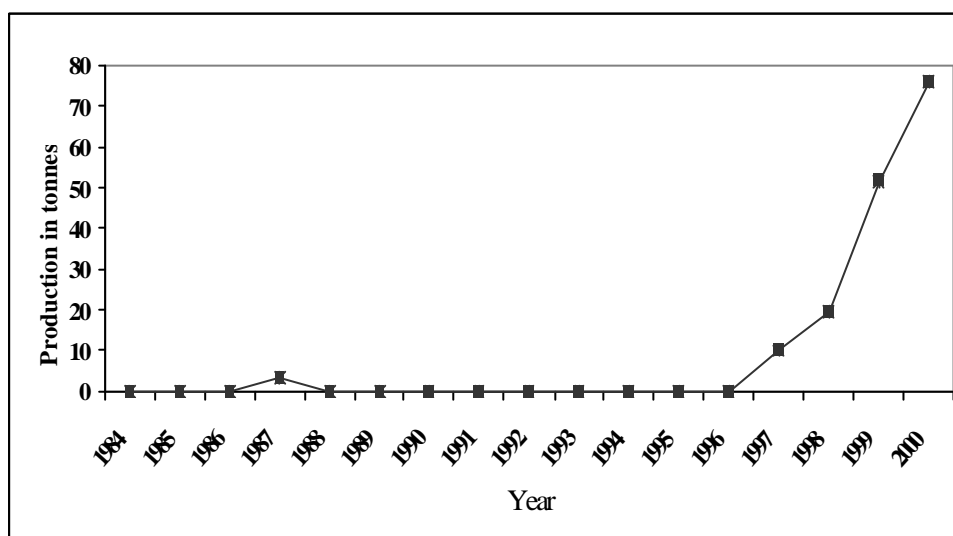


Figure 2. Cage aquaculture production in Bangladesh. Sources: CARE-CAGES database, Felix (1987).

### ***3. Technological, economic, social and institutional contexts of small-scale cage aquaculture***

**Output 2 describes the differences in research approaches and findings concerning small-scale cage culture and the rural resource poor in Bangladesh and Vietnam. It is from this that knowledge applicable on a regional scale is derived.**

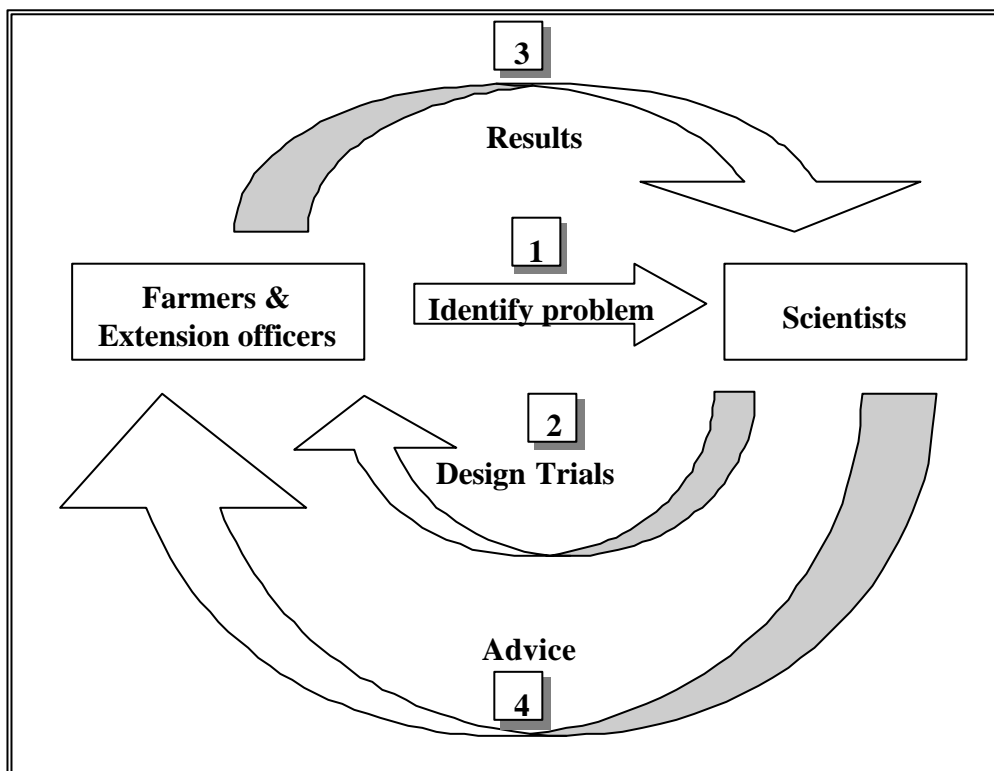
#### **3.1 Background**

In order to be of use to intended beneficiaries small-scale cage culture and associated research has to be appropriate to their technical, economic, social and institutional context. In Bangladesh this was achieved by utilising an array of participatory tools and staff experience to investigate researchable constraints identified by farmers, NGOs and CAGES staff. In Vietnam several distinct but co-ordinated approaches were used, each of which served to inform and refine the focus of the others. Participatory rural appraisal and institutional analysis was used to gain a full understanding of the nature and availability of local resources, the opportunities and constraints facing poor coastal people, and their aspirations and motivations. A survey of grouper seed fishing activity and its relationship with ecological habitats was undertaken to make an initial assessment of the sustainability of seed supply. A survey of supply and utilisation of ‘trash fish’ was undertaken to determine the sustainability of this feed supply and possible interactions with the market for fish for consumption by the poor. The work targeted three distinct groups: seed fishermen supplying the cage aquaculture farmers; cage aquaculturists themselves, and poor people who might benefit from entry to cage culture activities.

#### **3.2 Bangladesh**

As it is working with an existing development project, Project R7100 has access to a rapid and targeted conduit of communication, the Non-Governmental Organisations (NGOs) (Table 2), who are the driving force behind the current development of cage

aquaculture in Bangladesh. Through the CARE CAGES project the capacity of smaller NGOs to develop and disseminate small-scale cage aquaculture technology has been strengthened and there exists a synergy in the relationship between CAGES and the NGOs operating in the regions. CAGES has strong technical and training capability which, when coupled with the NGOs abilities to work with groups of rural households, allows cage aquaculture to be developed quickly and information shared on a wider scale than if agencies were operating independently. The partnership between a diverse range of organisations (Table 3), seems to be effective in the development and dissemination of aquaculture technology and is in marked contrast to past efforts that focused on developing cage aquaculture in isolation then disseminating it; a top down approach. The present, radical approach adopted by CAGES is to the advantage of Project R7100, utilising the existing framework to identify research needs, conduct participatory research and rapidly disseminate the results to those in need (Figure 3).



**Figure 3. The research framework of the Bangladesh component of R7100.**

Objectives were achieved through the use of:

1. Case studies examining the role of gender and reasons for cage culture abandonment;
2. Appropriate technology identification and testing;
3. Participatory impact monitoring and evaluation methods, examining the impacts of small-scale cage culture on the community;
4. Identification of specific opportunities and constraints of concern to farmers and CAGES;
5. The training and capacity building of collaborative institutions and staff.

### **3.2.1 Case studies**

As outlined in the literature review cage aquaculture has had a limited and largely unsuccessful history in Bangladesh and crucial in addressing this is an assessment of the social context of small-scale cage culture in the management of these systems. Once understood, this would enable CARE-CAGES staff to support the participation of women and help avoid disproportionately negative impacts. In order to identify specific constraints to the participation of farmers and to determine the expectations of beneficiaries of cage culture, the main reasons for the abandonment of cage culture were also investigated.

#### **Activities**

Designed to collect qualitative information, semi-structured interviews were conducted on selected households. Three villages were selected by TO Technical Officers (TOs), Assistant Project Officer (APOs) and NGO staff in each area that CAGES operates; Barisal, Comilla, Dhaka, Jessore and Shylet. The villages represented three levels of experience in cage culture: (i) just commenced cage aquaculture, (ii) a greater level of experience, and (iii) both a greater level of experience but with less successful uptake of the technology. Within each of the villages, three households involved in cage culture were chosen, representing various

levels of success (high, medium and low) based once again on the opinion of the CAGES TOs, APOs and NGO staff. There was widespread consultation among TOs, APOs and NGO staff to clarify methodologies and plans and to arrange times convenient with members of household to be interviewed. Wherever possible households with women cage operators were chosen.

### **The role of gender in small-scale cage culture.**

The main factors influencing the participation of women in cage culture are outlined in Table 4. Cultural and religious considerations were found to be predominant in determining the extent of women's participation in cage aquaculture, often restricting their contribution to auxiliary house-based tasks. This was particularly noticeable in the more conservative areas of the country such as Sylhet, where due to cultural restrictions or *purdah* women carried out time-consuming activities such as feed preparation inside the house. By comparison, in regions such as Dhaka and Comilla, cage culture decisions are made jointly between male and female household members. However, cage culture is still seen as a household activity, and feed collection, preparation and application, the most time consuming of aquaculture-associated tasks, fall to female members of the household. Such constraints, however, can be successfully addressed. In areas where NGOs had specifically targeted women they gained greater recognition from other community members and more independence in decision making.

The time devoted to various cage culture activities is shown in Table 5 and reveals quantitative information that can be considered alongside data concerning the division of household labour between the genders. For instance, the conservative cultural context of Sylhet could explain why on average men spend more time on cage culture activities whilst in other regions time appears to be more equally divided between genders.

With respect to time and associated financial opportunity costs the studies suggested that although the implementation of cage culture was borne differently by men and

women both had managed to reorganise their daily routine without detriment to other household activities.

In order to be remain effective and prevent current interest in cage culture by women fading, small-scale cage culture needs to address the two main gender goals in development, namely *efficiency and empowerment*. In this scenario ‘*efficiency*’ relates to aquaculture benefiting women through an increase in household income and improvement in the nutrition of the family. The involvement of women in small-scale cage culture appears to be achieving this goal. ‘*Empowerment*’ refers to the hypothesis that through controlling aquaculture activities women re-gain some measure of control over their own lives and improve their level of freedom and status. Progress here in the targeting of women by NGOs and in development projects still needs to be made. Visits to other cage operators and other means of increasing opportunities for first-hand observation appear to be the most efficient means of spreading information about the potential of cage culture to aid empowerment.

### **The reason for household abandonment**

The reasons for cage culture abandonment are summarised in Table 6. A range of factors was identified which served not only to identify specific issues to be addressed by technology evaluation e.g. choice of cage materials, see but also identified the need for lower-risk cage culture technologies and for appropriate entry points. A number of researchable constraints were also identified and investigated, such as the fish parasite in Jessore and training applied to tackle issues such as poor seed quality.

**Table 2. Partner and assistant partner NGOs collaborating with the CARE CAGES project.**

<b>Comilla</b>		
1	SEVA Manabik Unnayan Kendra	(SEVA)
2	People's Orientated Programme Implementation	(POPI)
3	Mollakandi Juba Samaj Kallyan Sangha	(MJSKS)
4	Association for Integrated Development	(AID)
5	Ujjeban Kendra	(UK)
6	Gandhi Ashram Trust	(GAT)
7	Village Development Center	(VDC)
8	Gana Kalyan Kendra	(GKK)
9	Palli Unnayan Shangha	(PUS)
10	Rural Advancement Committee for Bangladesh	(RAC-BD)
<b>Barisal</b>		
1	Aungkur Palli Unnayan Kendra	(APUK)
2	Shariatpur Development Society	(SDS)
3	Bangladesh Organisation for Development Co-operation	(BODC)
4	Village Development Association	(VDA)
5	Bangladesh Development Society	(BDS)
6	Bikalpa Unnayan Karmashuchi	(BUK)
7	Rural Development Organisation	(RDO)
8	Palli Punargathon Club	(PPC)
<b>Chittagong</b>		
1	GREEN HILL	GREEN HILL
<b>Dhaka</b>		
1	Rural Development and Improvement of Soil Fertility and Socio-economic Condition through Optimisation of resources	(RUDISOF)
2	Village Disability and Development Centre	(VDDC)
3	Pally Bikash Kendra	(PBK)
4	Bangladesh Rural Reconstruction Association	(BARRA)
5	Dishary Bahumukhi Samaj Kallayan Samity	(DBSKS)
6	Social Upliftment Society	(SUS)

<b>Jessore</b>		
1	UTTARAN	
2	Welfare Efforts	WE
3	Destitute Child and Human Development Organisation	(DCHDO)
4	Rural Unfortunate Safety Talisman Illumination Cottage	(RUSTIC)
5	Singer Khajura Bastuhara Samaj Kalyan Samity	(SIBAS)
6	Gramin Unnayan Sangstha	(GUS)
7	Jagoroni Chakra	(JC)
8	Banchte Shekha	(BS)
9	Srizony	
10	PRODIPAN	

<b>Natore</b>		
1	Rural Under Previlized and Landless Farmer's Organisation	(RULFAO)
2	Dulai Janakallyan Sangstha	(DJKS)
3	Banchte Chai Samaj Unnayan Samity	(BCSUS)
4	SWALLOWS	
5	NIJPATH	

<b>Sylhet</b>		
1	Jaintia Shinnomul Songstha	(JASHIS)
2	Voluntary Association for Rural Development	(VARD)
3	SHIMANTIK	
4	Friends in Village Development Bangladesh	(FIVDB)
5	Shapla Rural Development Society	(SRDS)



**Table 3. Uptake Pathways: the in-built promotional pathways utilised by the research project R7100.**

<b>Bangladesh</b>	<b>The Institute of Aquaculture, Stirling</b>
<b>Primary</b>	<b>CARE CAGES</b> project, R7100 acts as a research facility to CAGES development project
<b>Secondary</b>	As of 2000 CAGES interacts with 44 Partner NGOs ( <b>PNGOs</b> ) and 5 Associate Partner NGOs ( <b>APNGOs</b> ) throughout six regions in Bangladesh, Natore, Shylet, Barisal, Comilla, Jessore and Dhaka.
<b>Tertiary</b>	Each NGO has direct access to and interacts with the <b>rural resource poor and women</b> Throughout the six regions approximately 4000 households are taking part in cage culture activities and as a consequence the number of secondary adopters is increasing.

<b>Vietnam</b>	<b>The Asian Institute of Technology</b>
<b>Primary</b>	<b>The University of Fisheries</b> , Vietnam, is the main centre for fisheries and aquaculture training, education and research in Vietnam. It advises and collaborates with a range of local institutions including the <b>Oceanographic Institute, Research Institute for Aquaculture, the Department of Fisheries (local and national), the District and Provincial Peoples Committees</b>
<b>Secondary</b>	<b>The Department of Fisheries</b> deals with aquaculture and fisheries development policy throughout the country.
<b>Tertiary</b>	<b>The Provincial and District Peoples Committees</b> provide guidance and support to local communes with respect to all forms of social and economic development

**Table 4. The main factors influencing the participation of women in cage culture in Bangladesh.**

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<i>Distance from the water body</i>	Locating a cage close to the homestead is essential in encouraging the participation of women, as movement can be restricted <50 metres from the household in the more conservative areas.
<i>Decision to start cage culture</i>	Common to all regions was that the decision making process with regard to the start of cage culture, distribution of tasks and utilisation of fish produced and income is heavily dominated by male members of the household.
<i>Distribution of tasks and division of labour</i>	Feed collection, preparation and application roles generally fell to women when cage operators where of both genders as the division of household tasks was said to be based on necessity. This is not the case when women are specifically targeted by NGO and Project staff. Here women can manage their own cages and cage culture appears to integrate well into the households' livelihoods.
<i>Post harvest decision</i>	Generally, in less conservative areas women had a greater input into the decisions on use of fish harvested and income generated.
<i>Access to aquaculture knowledge</i>	Rather than learning through external extension services women appear to be learning about cage culture through observation and informal networks such as conversations with other women. The interest and curiosity generated by this relatively novel activity and exposure to, and observance of, current cage practitioners means that this knowledge could still reach many other potential beneficiaries.

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**Table 5. Daily time allocation on cage culture activities by men and women in Bangladesh.**

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	<i>Average Time - Women</i>	<i>Average Time - Men</i>
<i>Dhaka</i>	50 minutes	1 hour 5 minutes
<i>Comilla</i>	1 hour 5 minutes	49 minutes
<i>Sylhet</i>	2 hours 5 minutes	2 hours 43 minutes
<i>Barisal</i>	67 minutes	52 minutes
<i>Jessore</i>	1 hour	1 hour 30 minutes

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**Table 6. The main factors affecting the successful rearing of fish by cage operators in the Dhaka, Sylhet, Comilla, Barisal and Jessore regions, ranked in decreasing order of frequency of mention.**

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<i>Dhaka</i>	<i>Sylhet (*)</i>	<i>Comilla</i>	<i>Barisal</i>	<i>Jessore</i>
1. Escapees	1. Lack of co-operation	1. Poaching Poisoning	1. Initial mortality	1. Jute retting
2. Floods (1998)	2. Unequal share of workload	2. Net cutting (crabs)	2. Theft of cage and poaching	2. Poor net quality (nets cut by crabs)
3. Small fingerlings	3. Poor feed quality and feeding techniques	3. Fish mortality	3. Escapees during the 1998 flood	3. Aquatic weed decomposition
4. Poaching	4. Poor water	4. Escapees	4. Problems obtaining feed	4. Parasites
5. Fish mortality	5. Lack of care	5. Weather (storms)	5. Small cages	5. Boat theft

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(\*) Cages are managed co-operatively by a group of cage operators.

### **3.2.2 Technology evaluation**

Through the use of case studies project R7100 identified the need to reduce levels of risk in cage systems in order to facilitate the continued uptake by the rural resource poor. As small-scale cage culture is new to Bangladesh, there is an associated lack of endemic or 'practical knowledge' regarding this technology. In an attempt to tackle these factors both on-farm and research farm trials were implemented by project R7100 as mechanisms of assessing various cage culture options whilst exposing potential stakeholders to the technology.

#### **Activities**

CAGES currently collaborates with 45 local partner NGOs in six regions throughout Bangladesh (Table 2). In each region TOs (Technical Officers) from selected NGOs devised simple on-farm trials in association with project R7100 TOs and NGOs. Field trials were then carried out by rural resource poor and NGOs, overseen by CAGES TOs. Although mainly qualitative in nature, when collated these trials serve as valuable indicators from which appropriate cage technologies could be selected.

#### **Cage Design**

The main reasons for the failure of cage culture in Bangladesh to date has been the inability of local people to afford large, expensive cages, both in terms of capital costs and inputs required. Through these trials project R7100 has been instrumental in both development of cage design and the selection of materials appropriate to beneficiaries. Early cage design was based on those observed in the Philippines in 1995. From 1997 single fixed, inexpensive cages composed of bamboo frame were used. Unlike floating cages, however, fixed cages were found to be limited to shallow water. The 1 m<sup>3</sup> floating cages not only have a higher surface area:volume ratio and hence can hold more fish but they can also be moved relatively easily. Indeed the ease of management by farmers is the key reason for the widespread adoption of floating designs. A wide variety of construction materials have been tested through on-farm

trials, the principal frame materials at present being iron bar, PVC poles and bamboo. Bamboo was consistently found to be the cheapest and is easily managed due to its natural buoyancy. It also proved more durable than PVC, which tended to break, and was also locally availability and cheap. Netting was also examined and materials such as imported PVC, tire cord and nylon considered. Locally produced tire cord is more durable than nylon although at \$ 3.5 for a 1 m<sup>3</sup> cage it is more expensive than nylon (\$2). Imported PVC netting is the most expensive of all, costs being \$5 per cage.

Resource poor groups consider cage culture to be a high-risk activity. However, appropriate cage design can help minimise failure and maximise gains. Through the trials a cage design appropriate to the needs of beneficiaries has been delivered. The 1 m<sup>3</sup> bamboo cages are cheap and easily managed and households can afford to own more than one, spreading the level of risk.

#### **Low risk strategies and appropriate entry points.**

The case studies show that cage culture is subject to risks that affect both the participation of women and the level of cage culture abandonment. During 1998 approximately 13% of all cages operated by farmers working with the CAGES project suffered total losses. Traditionally, cage culture has focused on the production of table fish that requires a relatively long time period from stocking to harvesting. This creates difficulties for rural poor farmers targeted by development projects such as CARE - CAGES, the risk of a complete loss of stock continuing to increase until the fish are harvested. Farmers have difficulty in obtaining, and are un-willing to take on, credit in such a high-risk activity. From the experiences of the CARE – CAGES project and project R7100 there are, however, there are more appropriate entry points for poorer groups, such as the nursing of fry - fingerling stage, the over-wintering of fry - fingerling and the fattening of various wild caught species in cages. Table 7 describes start up costs and cash flow in terms of level of risk.

**Table 7. Low-risk strategies or entry points identified by project R7100.**

<i>Strategy</i>	<i>Assessment</i>
<b>Nursing</b>	<p><i>Risk</i> - Nursing reduces the level of risk by multiple harvesting during one season (March to November), in contrast to traditional grow-out. If losses occur restocking can take place. A similar loss in a grow-out system would result in a complete loss of production. An additional benefit is the reduction in poaching due to the production of small fingerlings considered less attractive</p> <p><i>Start-up costs</i> - Nursery systems are less expensive than grow-out cages. Feed inputs are reduced as although a higher protein content is required, the total quantity feed is reduced. Although fry required for nursing cost less per unit than the fingerlings required for cage culture, seed costs are higher reflecting the higher number of fry used. However, costs are not fixed and farmers can adjust stocking numbers.</p> <p><i>Cash-flow</i> - Several crops - and hence several incomes - are generated over a season with fingerlings being sold after 40 days. This is in contrast to on-growing, where there is a time interval between initial investment and any income. As many of the rural poor rely on loans to start up cage culture operations, the time interval can cause problems for farmers, the interest on any loan being around 20%.</p>
<b>Over-wintering of fry and fingerlings</b>	<p><i>Risk</i> - Over-wintering of fry to fingerlings for sale to other aquaculture ventures takes three months (early December - end of February), longer in duration than nursing and hence there is an associated higher level of risk. However the low risk of flash floods at this time of year and the reduced risks of poaching by comparison with the production of table fish reduces the overall chance of a total loss.</p> <p><i>Start-up costs</i> - As the over-wintering of fry is probably best visualised as an additional IGA by cage operators, utilising cages when they would normally be redundant, little costs in addition to those associated with on-growing are involved. The only exceptions are the cost of fry, minimal feed and cage repairs. The farmer is able to capitalise on the supply of high quality fingerlings during periods of low supply.</p> <p><i>Cash-flow</i> - Over-wintering can provide a year-round income from the cage(s). Moreover, farmers should have sold their</p>

	table fish and be in a position of credit when beginning to implement over-wintering.
<b>Fattening of wild-caught fish/prawns</b>	<p><i>Risk</i> - When cages are utilised by fisher communities for short term holding of fish until market prices improve or to increase fish size, there is a continuous cycle of fish being added and removed. The risk is much lower by comparison with on growing.</p> <p><i>Start-up costs</i> - These are reduced, relating only to the costs of cage and feed, as seed is supplied by the fishers themselves and feed costs generally only involve the use of time to collect snails and other protein sources. Trash fish is not used; the term is a misnomer in Bangladesh, as all fish can be consumed by humans and there is a reluctance to use such resources to feed fish.</p> <p><i>Cash-flow</i> - The addition and removal of fish provides a continuous income throughout the year. The high price for species such as <i>Macrobrachium sp.</i> also means that the system is highly profitable.</p>



### **3.2.2 Participatory impact monitoring and evaluation**

As identified in the literature review and in the case studies, the implementation of cage culture can result in conflicts between individuals and communities for the use of resources, manifesting themselves through poaching or cage damage. An essential element for the success of cage aquaculture therefore is its acceptance by, and incorporation into, the local community. As cage culture is a relatively novel technology in Bangladesh its impacts are unknown. Impact monitoring in the form of social surveys designed jointly by IoA and CAGES staff was therefore instigated. The participatory and culturally sensitive methods of investigation were chosen to attempt to identify potential conflicts whilst providing an understanding of the issues involved in the implementation of cage culture by stakeholders.

#### **Activities**

To investigate the impacts of cage culture village meetings and group mapping exercises were instigated and conducted concurrently with the case studies outlined in section 3.2.1. Once again prior to the survey TO, APO and NGO staff consulted villagers on the timing of the out the exercises. Community meetings were held to discuss survey objectives and to facilitate discussion of feelings and opinions about cage culture. These were followed by group-based mapping exercises in order to identify the multiple uses of the community water bodies and how cage culture might be accommodated. TOs, APOs and NGO advising whether it was appropriate to work with mixed or separate genders. The exercises proved effective, both cage and non-cage operators, including representatives from fishermen and other water users, women and children participating.

#### **Impacts of cage aquaculture on village communities**

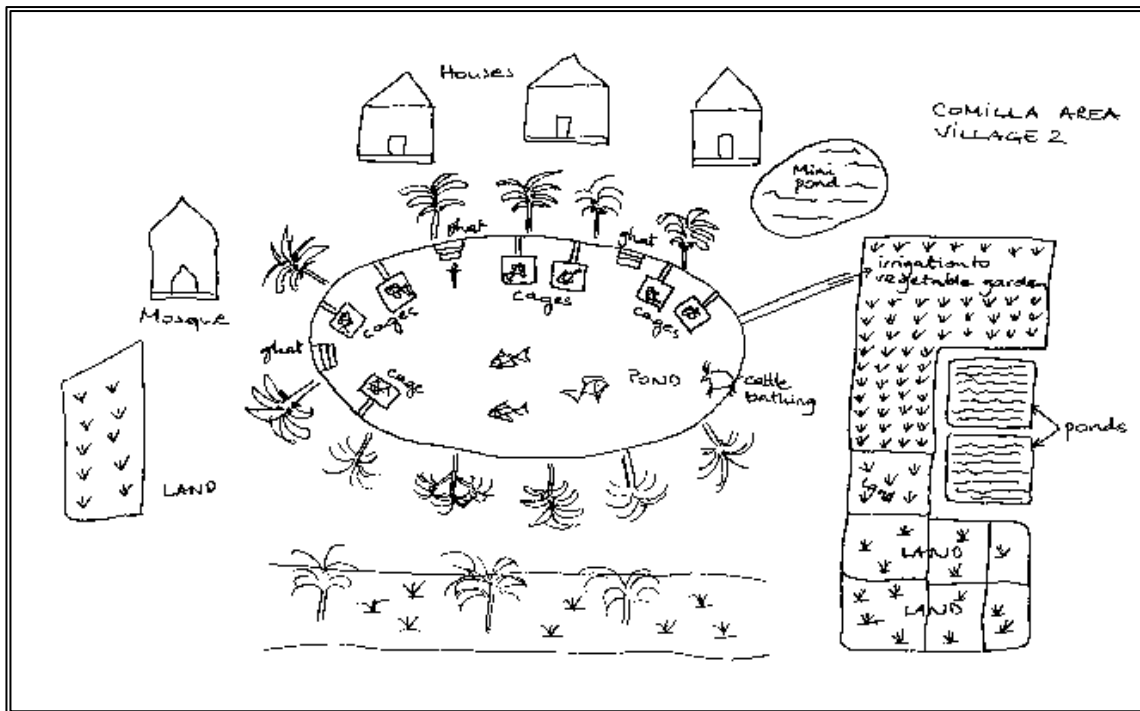
In Bangladesh water bodies are rarely used for a single purpose and cage culture is only one of many activities taking place in any given water body. The most commonly encountered water uses include:

?? Boating and river crossing	?? Duck farming
?? Washing and cleaning of utensils	?? Jute retting
?? Bathing	?? Irrigation
?? Cattle bathing and drinking	?? Bamboo transportation
?? Fishing	?? Cage aquaculture

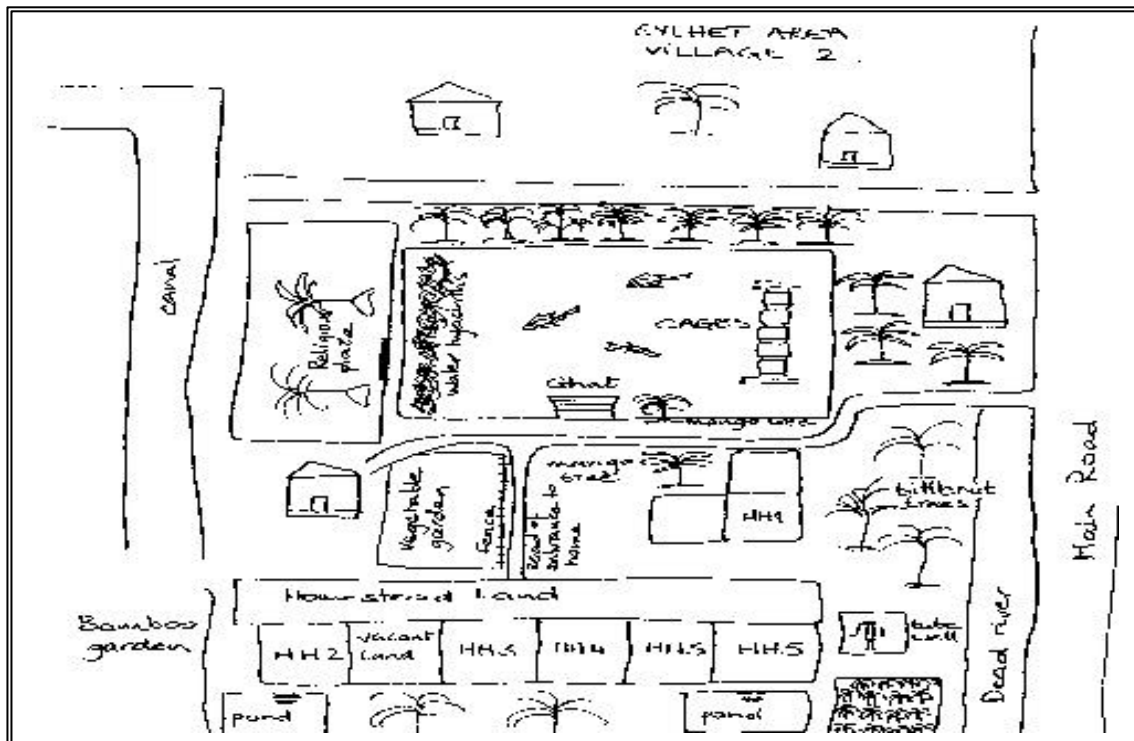
In most cases all groups interviewed felt that cage culture did not presently bear any negative impacts on other water users. In fact a wide range of benefits were identified (Table 8). Because cage culture is novel in Bangladesh and is highly visible, generates it generates a large amount of interest and curiosity among other stakeholders who observe the daily management practises and production, contributing to an increase in the social importance of practitioners. Due to the expected increase in cage numbers it is likely that the monitoring of cage culture will be required in the medium term in order to detect such conflicts and initiate appropriate control measures.

Although potential conflicts were not expressed directly by participants of the mapping exercises, examples of which are given in (Figure 4), changes that had occurred in the use of the water body were revealed. The changes had on the whole been accepted by community members and had not led to conflicts among resource users. However, if the situation was to be exacerbated by an increase in the number of cages, there is the potential for animosity and conflict between groups. At present, cage culture is accepted by villagers and at worst was described as a *bearable nuisance*'.

Figure 4. Examples of group resource mapping exercises.



(i) Resource map of the village of Mathargram, Comilla region



(ii) Resource map of the village of Dharon, Syhlet region.

**Table 8. The benefits of small-scale cage culture as expressed by stakeholders in the five regions of Bangladesh studied.**

Benefit from cage culture	Stakeholder groups
<b>Educational experience:</b> The implementation of cage culture has meant that new knowledge about new livelihood options has been gained. Awareness among children has been raised.	<i>Cage operators (Dhaka), Children (Sylhet)</i>
<b>Income generating activity:</b> Some groups have reported that cage culture has been observed to be profitable and is considered a viable livelihood option.	<i>Cage operators (Comilla), Children (Barisal)</i>
<b>A possible solution to unemployment</b>	<i>Other water resource users (Sylhet)</i>
<b>A possible solution to food shortages, in particular fish</b>	<i>Non-cage operators (Sylhet), Other water users (Sylhet), Children (Barisal) Women (Sylhet), Children (Barisal)</i>
<b>A source of encouragement to the community:</b> Stakeholders reported that due to the visual nature of cage culture, management techniques and success are easily observed. As a result, stakeholders are encouraged to take up this activity.	<i>Children (Sylhet), Cage operators (Sylhet), Cage operators (Comilla), children (Barisal)</i>
<b>Generating interest and curiosity in new livelihood options:</b> As small-scale cage culture is a relatively novel strategy, much interest in cage operators management practises and results are shown by other stakeholders. This is particularly noticed when fish from an operator's cage are used to entertain guests.	<i>Children (Sylhet), Cage operators (Sylhet), Cage operators (Comilla), children (Barisal)</i>
<b>Indirect benefits to other non-cage operators:</b> Fishermen from Jessore have reported that the feed lost from cages attracts fish to cage areas, reducing fishing effort. Additionally, setting nets in areas where cages are guarded prevents poaching. When tilapia are cultured, breeding sometimes occurs, the fry escape and can be collected by other users, sold or retained and used to seed the surrounding water body. Cage culture when practised in groups can also create a bond between members of the group and the wider community.	<i>Children (Barisal), Cage operators, (Sylhet)</i>

### **3.2.4. Specific constraints**

The involvement in a development project is necessary for research to have a direct impact on the livelihoods of the resource poor although the interaction between institutions is rarely a simple. Nevertheless, the strategy adopted by project R7100 clearly shows that the generation of knowledge can directly benefit the development process. During its two and a half year lifetime, the project also capitalised on the in-built development pathways to gain a good overview of the context of the rural poor.

#### **Activities**

By taking full advantage of the linkages, facilities and skills supplied, specific constraints of concern to farmers and CAGES could be identified. These ‘*researchable constraints*’ were addressed through the use of MSc studies and IoA consultants, and although not identified in the projects logical framework as they were not foreseen, became important components of the research process.

#### **Disease management**

One of the reasons for cage culture abandonment in Jessore was the impact of a particular, unidentified fish parasite region (Table 6). Identified as *Alitropus typus*, Milnes-Edwards 1840 by Professor Jean-Paul Trilles at the University of Montpellier Deux, an investigation was conducted by an MSc student. Through a series of tank trials and semi-structured questionnaires with cage farmers, fishermen and NGO staff, a preliminary investigation of the biology and ecology of the pathogen was made in order to assist in the development of an appropriate control strategy.

*A. typus* was found to be non-host specific, expressing a temporary lifestyle. The level of infestation varied between host species and it was suspected that the activity of potential hosts appeared to be a factor in determining parasitic burden. The prawns *Macrobrachium rosenbergii* or *M. malcomsonii* were tentatively identified as predators of *A. typus* and their use in areas subject to *A. typus* attack has been implemented on an experimental basis by CAGES.

On the whole pathogens are not a major issue within the CAGES project and cage aquaculture in Bangladesh but fish health issues do affect the success of many cage operators. Good fish health is, of course, essential for adequate fish growth and the economic viability of caged fish production. With the present relatively low density and number of cages in Bangladesh, specific pathogens such as *A. typus* are not a major problem, but as with conflict generation this may change with the expected expansion in cage numbers.

### **Database analysis**

The 1998 annual CARE-CAGES review raised concern about the overall effectiveness of the CAGES database. Data would frequently be incorrectly entered due to fundamental design flaws and limitations of the Excel™ spreadsheets. With the increase in the size of the dataset resulting from expansion of the project it became increasingly difficult to manage data effectively. An IoA consultant visited Bangladesh and discussed the database with CAGES staff. The aim was not only to analyse the database so that better advice could be passed to beneficiaries but also to raise the level of skills of CAGES staff in inputting and analysing data.

### **3.2.5. Training**

As in the examination of specific researchable constraints, training itself is not referred to directly in the project logical framework, but became an essential component in the research process. The knowledge and expertise of the IoA, combined with the promotional pathways in place facilitated the training of stakeholders and institutional staff. The organised workshops and seminars aimed to benefit NGO staff and TOs and the rural resource poor through the production of disseminatory leaflets. Training improved the quality of information and assisted in its effective transfer among stakeholders. It also added to the element of ‘capacity building’ induced through the participatory approach of case studies, on-farm trials and impact monitoring.

#### **Hapa breeding of tilapia**

As identified from the literature review and case studies a major problem faced by cage farmers in Bangladesh is the lack of availability and poor quality of seed. Seed and fingerling production was also identified by technology evaluation as a low risk option suitable for resource poor participation. Therefore, a workshop ‘*The hapa breeding of tilapia*’ was organised by CAGES, IoA and NFEP-2 staff and attended by representatives of these institutes and many of the partner NGOs. The aim was to produce and disseminate information on the production of fry for on-farm use or for sale to other aquaculture operators, ensuring timely and good quality supplies of fingerlings via the hapa breeding of tilapia. The basic guidelines on this low risk strategy has been outlined, 10,000 disseminatory leaflets in Bangla produced and distributed to collaborative NGOs and farmers.

### **3.2.6 Summary**

Through the use of case studies, technology evaluation and participatory impact monitoring an investigation of the technical, social, economic and institution contexts and role of small-scale cage culture in poverty alleviation has been instigated. The CARE - CAGES development project has responded to the research outcomes by refining its cage technology to meet the needs of beneficiaries. Additionally, specific risks or constraints have been addressed whilst training has introduced CAGES and NGO staff to new, low-risk strategies for dissemination.

Cage culture has been demonstrated to be a viable livelihood for the rural resource poor which facilitates the participation of women, although less so in the more religiously conservative regions. However the level of risk involved in '*traditional*' cage culture practises is significant enough to deter many from participating and hence the use of reduced risk options may be more suited to the socio-economic context of beneficiaries. The impact of cage culture presently remains positive with farmers and communities attributing benefits rather than negative associations to its implementation. It is therefore critical that there is not an uncontrolled expansion of cage culture and that the situation is monitored and controlled by development, government or community organisations. The improvement to the database is one such tool to help achieve this, particularly if production and social data are linked and serve as an example to the monitoring systems of other development projects. However, for long term solutions, beyond the lifetime of project R7100 and the CAGES project, it is with the capacity building of the rural resource poor and training of NGOs that awareness in cage culture issues is raised and rudimentary monitoring systems instigated.

### **3.2.7 Contribution of outputs**

The findings of the present studies serve as a major component in the planning and extension of small-scale cage aquaculture and the identification and refinement of systems appropriate to the rural resource poor. Without attention to these, projects have, in the past, failed to fully benefit their intended targets. Cage culture can be said



to have more in common with livestock management than traditional fishery practises with which farmers may be more familiar and as it is a novel technology in Bangladesh there is a lack of endemic knowledge. The participatory approach adopted by the R7100 and CAGES projects overcame this by not only investigating cage culture in the general context of the livelihoods of farmers but also by acting as a mechanism for the training of participants. Due to its highly visible nature, it also served to act as a demonstration to others interested in such technologies. Despite the initial lack of knowledge, as the CAGES project progresses the technology is becoming more refined to beneficiaries needs, a process assisted and accelerated by project R7100.

Because it was collaborative it is difficult to disentangle the relative roles of project R7100 and the CARE - CAGES impacts on the rural resource poor. The issues covered by R7100 may have been addressed by CAGES without the support of the research project, although they are likely to have been more modest in nature and suffered from lack of access to knowledge and skills afforded by the institutional link. The impacts upon beneficiaries and the numbers involved only becomes apparent in discussions with CAGES staff and management. The research project has impacted on the CAGES project and the rural poor through both direct and indirect routes (Table 9).

Although not identified by the log framework the element of training implemented by project R7100 is of 'added value' to the research process, the CAGES project and ultimately the rural resource poor. CAGES and NGO staff are trained in aspects of cage culture and can implement the knowledge in the field with cage farmers. This was of particular importance when considering the training on the hapa breeding of tilapia and production of fry produced in collaboration with NFEP-2 and due to the production of 10, 000 disseminatory leaflets beneficiaries have access to information on quality seed production a major constraint in Bangladesh. This low risk strategy practised in other countries was not promoted by the CAGES project until introduced by project R7100, it is now being implemented in all regions throughout Bangladesh.

The estimated number of operators utilising information gained from project R7100, such as in the selection of cage materials, according to CAGES staff, includes 2830 of 4000 households, equivalent to 73% of operators. The number is expected to extend beyond the project and its lifetime through secondary adopters who are presently replicating the technique for themselves. The use of case studies and participatory impact monitoring can also claim to have benefits, identified by CAGES staff as the provision of a grounding in research methodology and a valuable baseline with which future findings can be compared. The benefits accrue not only to all those targeted by project R7100 but also to all that share the resources associated with cage culture.

**Table 9. The contribution of the participatory approaches implemented by Project R7100 to the CAGES project, the rural resource poor and the associated constraints.**

<i>Outputs</i>	<i>Benefit to CAGES project</i>	<i>Benefit to the rural poor</i>	<i>Constraints</i>
<i>Case studies</i>	<p>?? Provide valuable baseline social information, that facilitates identification of emerging trends</p> <p>?? Understanding the role of women and reasons for cage abandonment assists in refinement of technology and identifies specific constraints for further research</p> <p>?? CAGES staff participate and gain experience in social surveys through the participatory approach adopted</p>	<p>?? Opportunities and constraints involving women's roles and the abandonment of cage culture identified and dealt with more rapidly.</p> <p>?? Surveys raises awareness in cage culture activities in poor and target groups such as women</p>	<p>?? Small sample size, time and financially restricted</p> <p>?? Subjective selection of village and villagers could cause bias.</p>
<i>Technology evaluation</i>	<p>?? A more rapid refinement of new technology than would normally occur</p> <p>?? Range of systems and topics which can be tested are fairly unlimited</p>	<p>?? Yields a realistic assessment of the validity of various technologies and assists in its development</p> <p>?? Appropriate cage culture strategies and inputs identified</p> <p>?? Highly visible nature of trials raises awareness of cage culture techniques among farmers, creates curiosity in others</p>	<p>?? No controls and trials of simple look and see nature, only valuable as a qualitative form of information when collated</p> <p>?? If trial fails could deter farmers.</p> <p>?? Not subject to controlled scientific procedure due to social and financial constraints.</p>

<p><b>Participatory monitoring</b></p>	<p><b>impact</b></p> <p>?? Initial impacts concerning the implementation of the new technology are identified more rapidly</p> <p>?? Provides a valuable baseline of impact information, with which future comparisons can be made identifying emerging trends.</p> <p>?? CAGES staff participate and gain experience in social survey methodology such as resource mapping.</p>	<p>?? Trends on the impact of cage culture identified and dealt with more rapidly.</p> <p>?? Exposure to surveys raises awareness in cage culture in poor, facilitates self-monitoring within the community.</p>	<p>?? Small sample size, time and financially restricted.</p> <p>?? Subjective selection of village could cause bias in results.</p>
<p><b>Researchable constraints</b></p>	<p>?? Constraints of immediate concern to CAGES project dealt with e.g. database revealing hidden constraints such as NGO transparency problems.</p>	<p>?? Constraints of immediate priority to farmers identified and dealt with e.g. flooding, parasites or poaching.</p>	<p>?? Priorities are subjective varying between regions and individuals.</p> <p>?? Research limited by time and financial constraints.</p>
<p><b>Training</b></p>	<p>?? Skills and knowledge of research institutions passed to development project quickly.</p>	<p>?? Development (NGO) staff are more efficient and have greater knowledge of cage culture benefiting poor, having access to resources not previously available.</p>	<p>?? Time and financial constraints.</p> <p>?? Other topics could be tackled such as the development of appropriate feed selection and supply.</p>

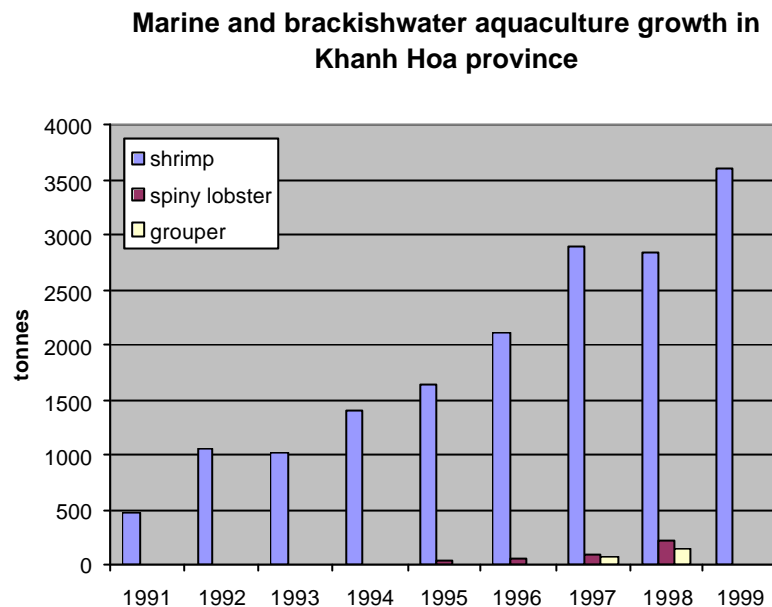
### **3.3 Vietnam**

In Vietnam several distinct but co-ordinated approaches were used to develop a thorough understanding of the needs, aspirations and capacity of local people, and the potential of cage culture to meet these needs and develop in a sustainable manner. We worked mainly through and with the University of Fisheries, Nha Trang, whose staff have well established connections with the aquaculture and fishing industry in Khanh Hoa. Several of the staff had previously undertaken research and training with the Asian Institute of Technology on social and environmental issues related to aquaculture development, and were well acquainted with the various techniques.

The first stage was assimilation of existing information on relevant natural aquatic systems, the population, and the current status of cage aquaculture development in Khanh Hoa province. Participatory rural appraisal and institutional analysis was used to gain a full understanding of the nature and availability of local resources, the opportunities and constraints facing poor coastal people, and their aspirations and motivations. A survey of grouper seed fishing activity and its relationship with ecological habitats was undertaken to make an initial assessment of the sustainability of seed supply. A survey of supply and utilisation of “trash fish” was undertaken to determine the sustainability of this feed supply and possible interactions with the market for fish for consumption by the poor. This work targeted three distinct groups: seed fishermen supplying the cage aquaculture farmers; cage aquaculturists themselves, and poor people who might benefit from entry to cage culture activities

### 3.3.1 Aquaculture development trends in the province

Figure 5



Marine and brackishwater aquaculture is developing rapidly in Khanh Hoa Province (Figure 5). The growth began with brackishwater pond culture mainly of shrimp, but also of some grouper. Since 1954 cage culture has developed rapidly, initially of grouper, and in recent years lobster. The very rapid growth in lobster culture has continued in 1999 and 2000 although official statistics are not yet available.

Cage culture in Khanh Hoa province is currently dominated by the culture of groupers (*Epinephelus* spp) and Lobster (*Panulirus* spp.). Culture of the former has been described by Trai and Hambrey (1997). Lobster culture has developed more recently and culture techniques are still developing.

In both cases production is dominated by family enterprise, owning 1 or a few cages located in the lagoons and sheltered bays which dominate the coastline of Khanh Hoa. Cages are typically 10-30m<sup>3</sup> in volume, and made of synthetic netting suspended from bamboo frames. Floating cages are also used, which utilise bamboo and plastic drums for flotation. Cages tend to be aggregated in groups related to the quality and convenience of the site, and also to facilitate transport, share labour etc.

Although the development of cage culture has been very rapid in recent years, many suitable sites remain, although these are less convenient in terms of access than those developed to date.

Seed supply is from the wild for both grouper and lobster, and in both cases a wide range of seed is used ranging from around 3cm to 10cm. Seed is usually caught in traps by local fishermen, although lobster is also occasionally caught by hand.

Feed is trash fish and shellfish, either purchased from dealers at local markets or caught locally and used directly.

Selling is typically through local dealers who supply a few major exporting companies based mainly in Ho Chi Minh City. The majority of fish and lobster are sold and marketed live.

Shrimp farming is suffering chronic disease problems with approximately 30% of the production areas hit by disease in 1999. No disease has so far been encountered with lobster culture, and very little for grouper.

### 3.3.2 The People

#### Activities

A range of rapid rural appraisal and participatory rural appraisal tools and techniques (Theis and Grady, 1991; Pido et al., 1996; Townsley 1996) were applied to study seventeen coastal villages belonging to 4 coastal districts (Van Ninh, Ninh Hoa, Nha Trang, Cam Ranh) in Khanh Hoa province (Thuong 2000). The survey covered 45% of coastal communes in the province. The study amounted to a livelihoods analysis, but with a particular focus on the desirability or otherwise of entry to aquaculture, and the opportunities and constraints to entry and success. The study included households already engaged in aquaculture and households not involved in aquaculture.

The methods used and issues discussed are summarised in Table 10.

**Table 10. RRA/PRA Research outline Khanh Hoa**

Topic	Sub-topics	SSIs with individual villagers (95 households)	SSIs with key informants	SSIs with Groups	Direct Observation	Secondary Sources	Ranking exercises (groups)	Diagrams and transects (groups)
Livelihood of poor coastal people	?? Household size and dependents	X			X	X		X
	?? Education	X	X	X	X	X		X
	?? Occupational structure	X		X		X		
	?? Labour seasonality and availability	X	X			X		
	?? Household income and expenditure							
	?? Loan and credit status							
	?? Perceived qualities/important characteristics of current and potential							



	economic activities; ?? Threats and constraints to improved livelihoods							
<b>Opportunities and constraints to entry in cage mariculture for potential farmers</b>	?? Reasons for considering entry ?? Opportunities (natural conditions etc) ?? Constraints (natural; technology; financial; institutional)	X X	X X	X X			X X	
<b>Opportunities and constraints to entry and success in cage mariculture for actual farmers</b>	?? Opportunities (natural conditions etc) ?? Constraints (natural, financial, institutional)	X X	X X	X X			X X	

(SSIs= semi-structured interviews)

### Outputs

### Socio-economic profile of poor coastal villages

Average per capita GDP in the province was \$292 in 1997. Average household size was 6 members, two of whom were typically involved in full time labour. Most villagers were only educated to primary level and levels of illiteracy were high. For example, in one village (Le Cam) with 274 people, 245 were illiterate. In only one District (out of 4 surveyed) were significant numbers educated to High School level.

The poor coastal people lived mainly on inshore fishing, agriculture (crops, livestock, poultry) and (increasingly) aquaculture. Other common activities included trade, tailor and charcoal making. Many households had main and subsidiary activities, although fishing households tended to be specialist.

In practice there were 4 main village types:

1. Off-shore fishing and others;
2. Inshore fishing and others
3. Aquaculture and others; and

#### 4. Agriculture and others

The poorest communities were those dependent on inshore fishing. In many cases, and unlike the general trend in Vietnam, these communities were getting poorer as a result of over-exploitation and declining yields from inshore fisheries. An example of a transect through one village, showing activities and problems, is presented as Figure 6.

Mean per capita income of villagers surveyed was \$220, but varied widely, between households (range 36 to 722) and between districts (district average 111-373). In general households engaged in inshore fishing were the poorest. Per capita income was significantly higher for households engaged in aquaculture (\$299.6+/-\*\*\*) compared with others (\$157.1+/-\*\*\*). Furthermore annual saving rate was ten times higher in aquaculture households (US\$936 and \$86 respectively\*\*\*).

The labour calendars and occupational structures showed that there was much free labour available in most villages, except for those engaged in offshore fishing. However, in inshore fishing villages, the time of labour availability was constrained by tides.

41% of (95) households studied were in receipt of state loans. These loans were normally subject to a poverty alleviation credit with reduced interest rates (0.6 to 1% per month compared with a normal bank rate up to 2.7% per month). 7.4% of households were in receipt of loans from money lenders at rates as high as 10% per month. A specific problem with all loans was the required payback period – typically 6 months – compared with requirements for aquaculture investments (typically 2 years). Perhaps as a result of this aquaculture households were more dependent on private money lenders.

#### **Problems and constraints to improved livelihoods**

Problems and constraints to improved livelihoods included the following (not in order of priority, which varied widely between villages):

- ?? Low income;
- ?? Dense population and lack of land;
- ?? Poor and/or impoverished soils;
- ?? Shortage of freshwater;
- ?? Forest fires and mangrove destruction;
- ?? Shrimp disease;
- ?? Flooding;
- ?? Erosion;
- ?? Overexploitation of fisheries;
- ?? Use of destructive fishing gears (e.g. cyanide, electric fishing push-nets);
- ?? Degradation of coral reef;
- ?? Pollution from shrimp farming shrimp hatcheries, and animal husbandry;
- ?? Poor roads;
- ?? Access to markets

### **Interest in aquaculture**

Almost all households, and groups not currently engaged in aquaculture expressed strong interest in entry. Reasons for considering entry to aquaculture (all forms) included:

- ?? increased employment;
- ?? economic diversification;
- ?? increased income (compared with agriculture), and
- ?? maximising the use of available aquatic resources

### **Perceptions of the quality and suitability of existing activities**

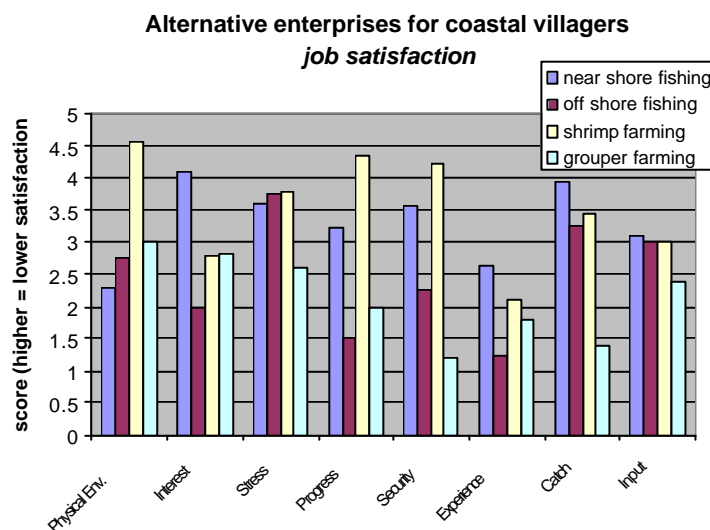
Groups of villagers were asked to list the key characteristics of their current occupations and activities in terms of their suitability/unsuitability to meet their aspirations and livelihoods needs, in order to assess their sense of job satisfaction and/or quality of life. Considerable discussion and prompting was required to specify

these characteristics, which varied somewhat between occupations, but the following were finally agreed:

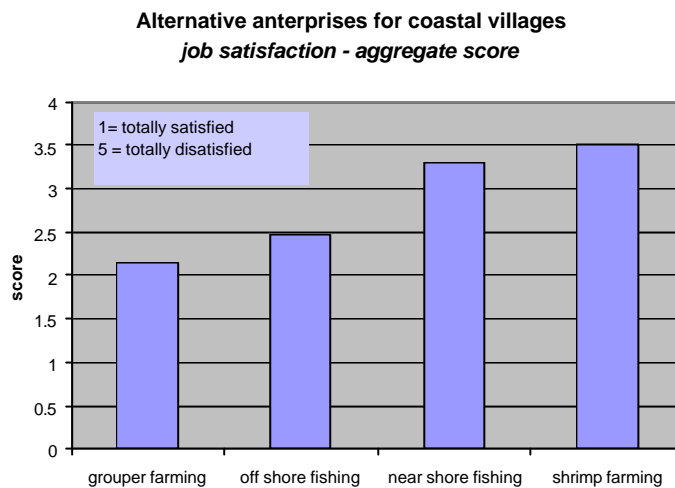
1. Physical environment (shelter, comfort etc);
2. Interest/stimulation
3. Stress
4. Sense of progress/creativity;
5. Security of income/employment;
6. Tradition/habit/experience;
7. Output (Catch/production);
8. Inputs (quality, availability etc)

A survey was undertaken of 42 individual households to determine how they rated their main activity against these criteria Figure 7.

**Figure 7**



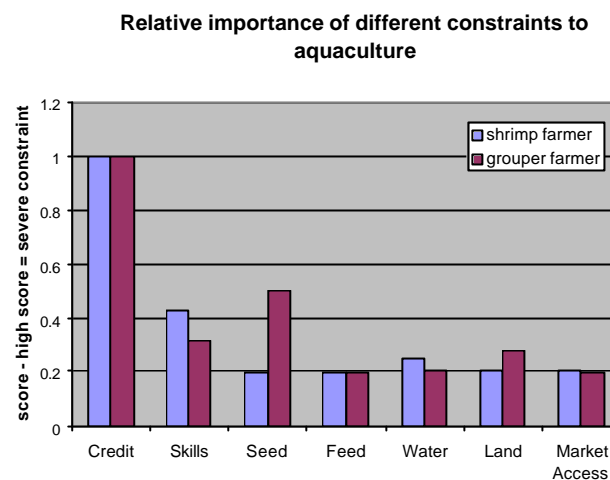
**Figure 8.**



It is notable that near-shore fishing and shrimp farming scored rather badly against most criteria while grouper farming and offshore fishing scored relatively well. When the scores for the various criteria were aggregated (arithmetic – no weighting) into a single index, the differences are even more obvious (Figure 8).

Households were also questioned in relation to the main constraints to successful pursuit of different activities. These included: credit; skills; seed; feed; availability of appropriate quality land; availability of appropriate quality water; market access. A summary of results is presented in Figure 9.

**Figure 9**



### **Constraints to entry (as perceived by those not engaged in aquaculture)**

Perceived constraints to entry in terms of *natural conditions* included:

- ?? shortage of fresh water (for human consumption at possible aquaculture sites);
- ?? natural disaster (flood, typhoon);
- ?? infertile soils (relevant to pond aquaculture); and
- ?? problems associated with shrimp farm effluents (salination; pollution).

The relative importance of these constraints varied widely between districts according to local conditions and opportunities.

Perceived *investment constraints*, in order of priority, included:

- ?? shortage of investment capital;
- ?? lack of knowledge of the nature and profitability of alternative enterprises;
- ?? high interest rates;
- ?? inappropriate loan repayment schedules; and
- ?? poor management of existing financial resources.

Immediate needs, in terms of facilitating access to the potential benefits of aquaculture were:

- ?? Appropriate finance packages;
- ?? Improved technical knowledge;
- ?? Allocation of appropriate water area;
- ?? Appropriate policies

**Constraints to success (as perceived by those already engaged in aquaculture)**

Most cage farmers perceived aquaculture positively, with 13 out of 17 interviewed intending to expand production. Their suggestions in terms of immediate needs to make aquaculture more successful included improved technical support (67%), improved supply and quality of seed (67%); lower interest loans (57%) and higher farm gate price (52%)

### **3.3.3 Policy and Institutional issues**

#### **Activities**

Relevant documents were assembled relating to aquaculture policy and planning. A workshop was held to discuss institutional relationships, and opportunities and constraints in relation to sustainable aquaculture development. Institutional issues were raised in discussions with farmers and villagers during survey and PRA activities.

#### **Outputs**

The government administers all affairs related to national fishery development, mainly via the Ministry of Fisheries (MOF). The MOF controls all institutions in its sector in order to fulfil annual, five-year, and long-term plans, which are set by the national assembly or the central government. It has the right to issue legal documents in order to implement decisions made by the national assembly and the central government. The MOF's stipulations affect all ministries, People's committees, institutions, and citizens in the whole country (National Institute for Administration, 1995).

The Central Government in general, and the MOF in particular, has paid much attention on cage culture. According to the Circular No. 709-TS/QLNL (MOF, 1994<sup>a</sup>), there were 5 fisheries extension programs in which the cage culture program was considered to be important. The program's target is that by the year 2000, the total production of cage culture, including freshwater and marine culture, should reach 105,000 metric tons with an export value of USD 30-60 million, and create 60,000 employment (MOF, 1994<sup>b</sup>). For marine cage culture, the target is 10,000 cages with a yield of 80-90kg per cubic metre, corresponding to a production of more than 1000 metric tons by the year 2000.

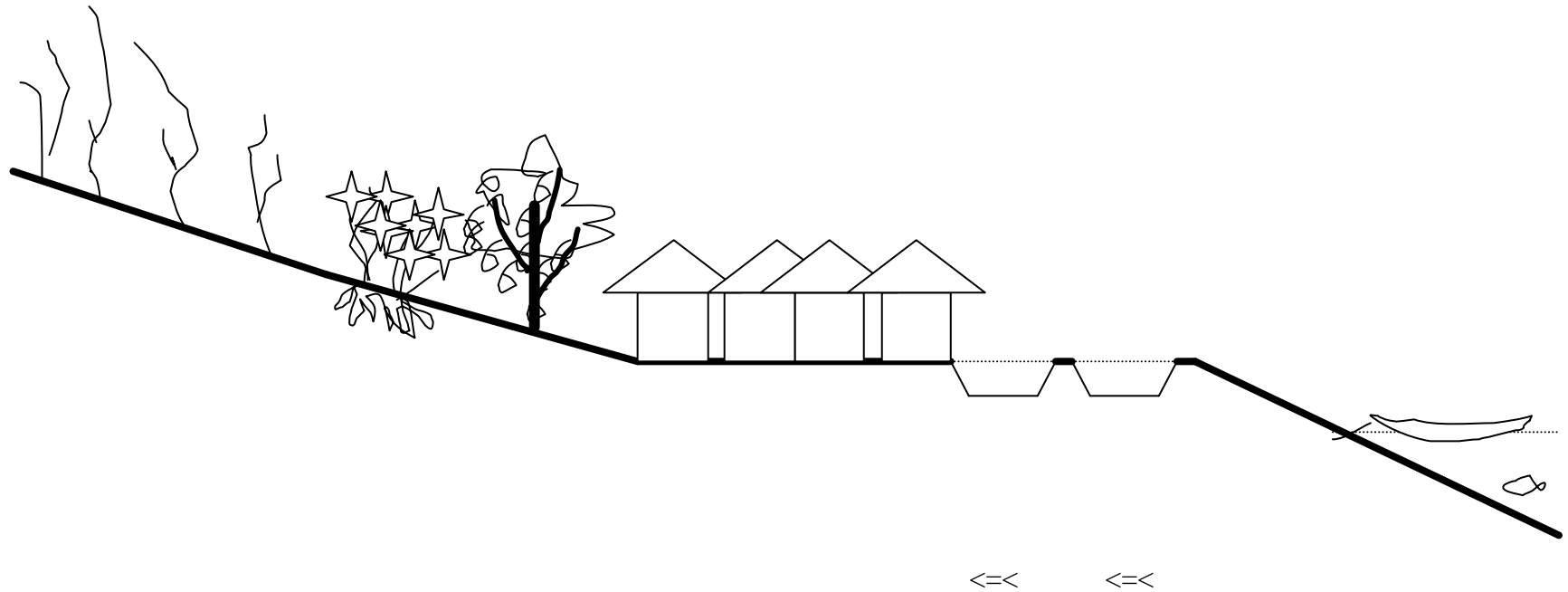
More recently the Vietnam Programme on the Development of Aquaculture in the period 1999-2010 (Decision 224/1999/QD-TTg) has been adopted. Its objectives are:



- Develop aquaculture to meet a demand in food security and create a main source of material for export;
- Achieve a total of 2 million tonnes in aquaculture and total export value of US\$2.5 billion by the year 2010;
- Create jobs for 2 million people;
- Contribute to develop economy and society of the country and security of the coastal region

Based on the MOF's direction, provincial DOFs in coastal provinces are making plans for the development of aquaculture in general, and marine cage culture in particular, in each province in order to fulfil their tasks by the year 2010.

**Figure 6. TRANSECT of LE CAM VILLAGE, NINH HOA DISTRICT  
showing ACTIVITIES and PROBLEMS**



<b>Area</b>	<b>FOREST</b>	<b>FIELDS</b>	<b>SETTLEMENT</b>	<b>PONDS</b>	<b>LAGOON</b>
Activities/ Land-use	<ul style="list-style-type: none"> <li>▣▣ Firewood collection</li> <li>▣▣ Afforestation</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Crops:</li> <li>-cassava</li> <li>-cashew</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Housing</li> <li>▣▣ Husbandry: pig, poultry</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Shrimp farming</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Fishing</li> </ul>
Problems	<ul style="list-style-type: none"> <li>▣▣ Forest fire</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Low income</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Dense population</li> <li>▣▣ Poverty</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Small farming area</li> </ul>	<ul style="list-style-type: none"> <li>▣▣ Over-exploitation</li> <li>▣▣ Harmful gears</li> </ul>

Danida is now assisting and facilitating the government of Vietnam in a comprehensive program, Support for Marine and Brackishwater Aquaculture (SUMA). This includes support to Provincial governments in the development of planning for sustainable aquaculture development. Khanh Hoa has been selected for local and provincial level pilot planning projects because of the rapid development of aquaculture, and the quality of information now available (some of which has been provided by this project)

Aquaculture in Khanh Hoa Province can draw upon significant technical expertise from the Provincial aquaculture extension programme and various research and teaching/training institutions including the Oceanographic Institute, the University of Fisheries, and the Research Institute for Aquaculture (3).

Institutional support for aquaculture is therefore strong. From the point of view of sustainable aquaculture there are however weaknesses. This relates mainly to the production target approach to development planning. In most provinces in Vietnam there is limited capacity to take account of social and environmental issues and the "quality" of development. It is a major objective of the SUMA project to strengthen capacity in this area, but while development is target (and these targets are ambitious) driven, social and environmental concerns will necessarily take second place. Central government must itself promote a more integrated approach with broader social, environmental and economic targets, which can be applied more flexibly at local level if sustainable aquaculture is to be promoted.

Some further constraints were identified during meetings and workshops with government departments, agencies and research/training institutions:

?? DOF has not enough power to manage all issues related to the development of aquaculture and fisheries in the province. The DOF is not the final decision-maker. It works as a consultancy unit for the Provincial People's Committee. Its documents sent to districts are not mandatory.

?? At district level, there is no fishery office. Only one person in the agriculture office is responsible for fisheries. Therefore, there is a shortage of manpower to implement DOF's plans at district and commune levels.

Notwithstanding these reservations, there are significant strengths in the Vietnamese system. Given the will and the appropriate direction, policies can be developed and implemented rapidly. It is notable that farmers and villagers in the survey (see previous section) did not perceive institutional and policy matters as major issues or constraints.

### **3.3.4 The sustainability of seed supply**

#### **Activities**

A broad based study was undertaken between January and July 1998 which examined technical, environmental, and socio-economic issues related to wild grouper seed supply in Khanh Hoa in order to assess the prospects for the sustainable development of grouper culture in the province as well as elsewhere in Vietnam. Field work for the study was carried out from December 1997 to April 1998 in four districts of Khanh Hoa Province (Van Ninh, Ninh Hoa, Nha Trang, and Cam Ranh) which are the main areas for grouper seed supply and grouper culture in Central Vietnam.

The study used existing information, supplemented with an interview survey of fishermen (260 of 649), and a physical/ecological survey of catching grounds. Parameters related to grouper seed supply, such as physical and ecological characteristics of catching areas, technical attributes of seed fisheries, and market and socio-economic aspects of seed supply, were recorded and investigated using a framework adapted from Pido et al. (1996). The method of determining the coverage of seaweed, sea grass and coral was modified from the method in “ Survey manual for tropical marine resources” (English et al., 1994). Grouper samples were collected and identified based on the FAO key (FAO 1993). The ecological data was analysed using cluster analysis, as developed in the ADE 4 package (University of Lyons). The methodology and results have been described in detail elsewhere (Tuan 1998, and Tuan and Hambrey (in prep)).

Unfortunately no study was undertaken of the seed supply for the cage culture of lobsters. This was because lobster culture only developed to a significant scale during the project.

## **Outputs**

### **Ecological attributes of catching areas**

Four major *catching areas* were identified. These areas were all characterised by the presence of sea-grass “forest” or seaweed beds. Two sea-grass species were common to all areas: *Thalassia hemprichii* and *Enhalus acoroides*. Within each area were several catching sites where the bulk of fishing for seed took place, amounting to a total of 16 *catching sites*. Cluster analysis revealed three broad types of catching site, corresponding closely to the conventional classifications of coral reef, lagoon and estuary.

A significant proportion (almost 40%) of the seed came from one catching area, Nha Phu lagoon, a well-known nursing ground for many marine organisms.

### **Species and habitat preference**

In total, seven species of seed grouper were caught regularly at the various sites. Using the key provided by FAO (1993), the species were identified as in Table 11.

**Table 11. Grouper species collected in Khanh hoa**

Scientific name	FAO English name	Local name
<i>Cephalopholis miniata</i>	Coral hind	Ca mu do
<i>Epinephelus akaara</i>	Hong Kong grouper	Ca mu cham do, Ca mu tieu do
<i>Epinephelus bleekeri</i>	Duskytail grouper	Ca mu soi, Ca mu tieu den
<i>Epinephelus coioides</i>	Orange-spotted grouper	Ca mu song
<i>Epinephelus malabaricus</i>	Malabar grouper	Ca mu me
<i>Epinephelus merra</i>	Honeycomb grouper	Ca mu cham to ong
<i>Epinephelus sexfasciatus</i>	Sixbar grouper	Ca mu sau soc

Seed production from the catching sites was related to ecological variables, and the nature of the relationship varied between species. Production of most species increased with increasing sea grass cover. *E. akaara*, on the other hand, was collected at sites with a specific level (31-50%) of seagrass cover. Sea-grass cover was the most important variable explaining variation in abundance of seed of most grouper species. For example, it explained 94% of the variation in seed production of *E. coioides* and *E. merra*, but less in other species.

In the six “black grouper” species, seed production declined with increasing depth and increasing salinity. Production was negatively related to coral cover in all species except for *E. coioides* (no relationship) and *E. akaara* (positive relation). Production of *E. akaara* and *E. merra* was positively associated with seaweed cover, while this relationship was negative for other species.



### Fishing for seed

649 households (6.5% and 0.6% of fishing households and rural households in the province respectively) collect approximately 200,000 seed each year, mainly “black grouper”: *Epinephelus akaara*, *E. bleekeri*, *E. coioides*, *E. malabaricus*, *E. merra*, and *E. sexfasciatus*. In addition, “red grouper” *Cephalopholis miniata*, a commercially important species, are caught and held temporarily for export to Hong Kong and Taiwan.

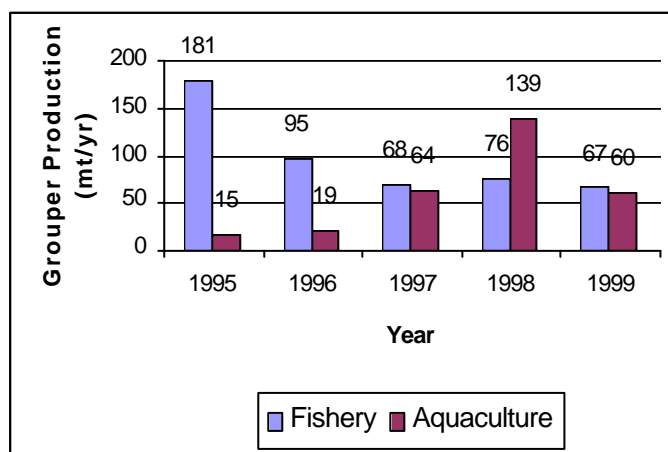
A variety of gears are used according to season and size of seed, including seine net, scoop net, push net, pipe trap, palisade, aggregation devices (artificial reefs, branches) with encircling nets, bamboo traps, hook and line, and encircling nets around natural reef.

### Status of the fishery

According to the fishermen, they had to spend more time to catch the same amount of seed compared with previous years. Seed production appears to be in decline, as is the capture trend for grouper in the province (Figure 10), and the demersal marine finfish (Figure 11) ( Tuan, in press).

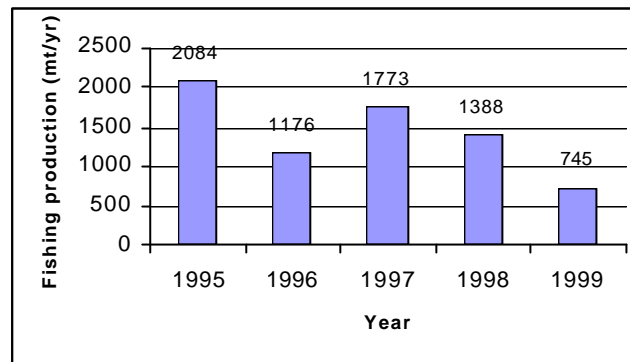
**Figure 10. Production trends for adult grouper in Khanh Hoa Province**

(Note: only 6 first month data of 1999 were collected)



**Figure 11. Capture trend for commercially important demersal marine finfish in Khanh Hoa province**

(Note: only 6 first month data of 1999 were collected)



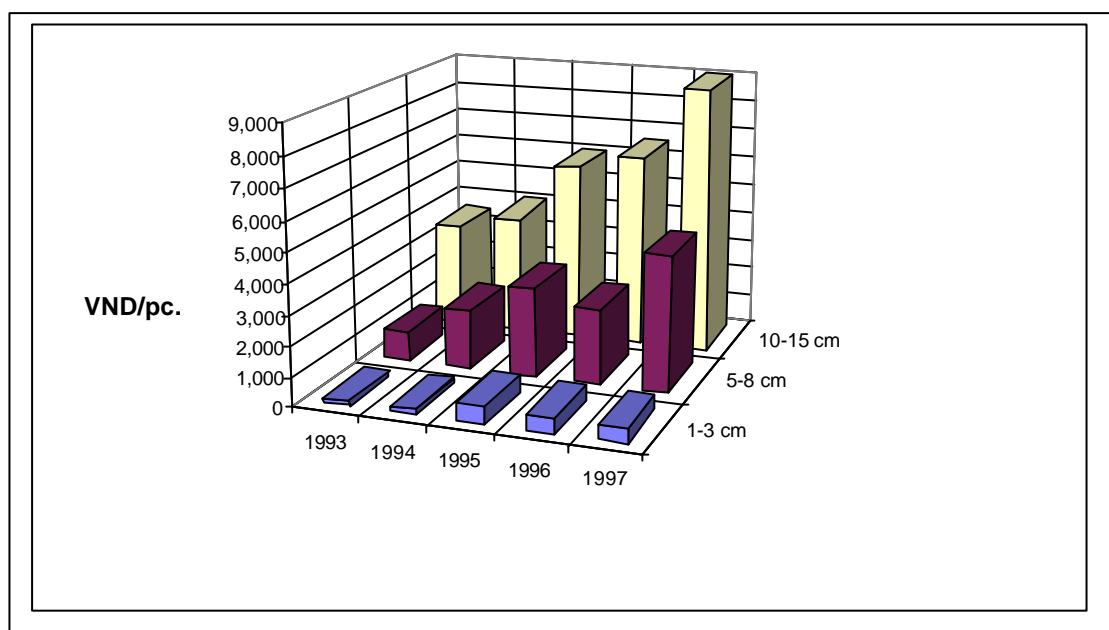
The reasons for the decline of fishing production of commercial demersal marine finfish in general, and grouper in particular probably include overexploitation, especially of broodstock; using harmful fishing gears such as motorised push-nets, trawling nets, dynamite, and sodium cyanide; and nursery habitat destruction.

### Market attributes

The fishing production of grouper seed in the province has remained at about 200,000 pieces per year in recent years. The four species *E. malabaricus*, *E. coioides*, *E. sexfasciatus*, and *E. bleekeri* were the main cultured species (Figure 12). Six species had the common name “black grouper”, and commanded similar price.

**Figure 12. Seed production by species**

The pricing system varied according to time and location. The price ranges by fish size in 1998 are shown in Table 12.



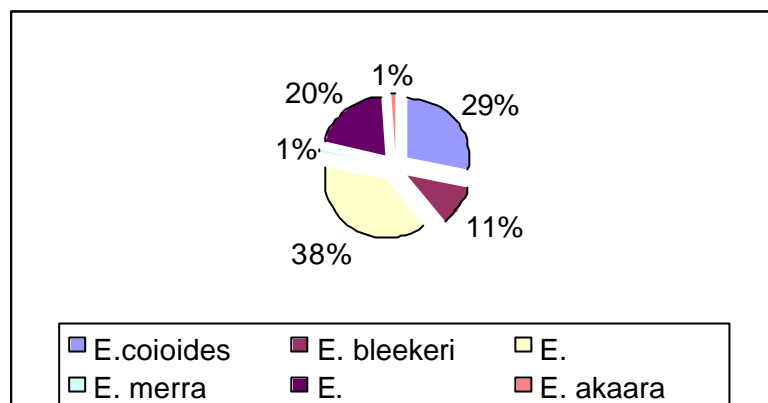
**Figure 13. Price Trends for Grouper Seed in Khanh Hoa Province Vietnam (Trai and Hambrey 1988) (1US\$=ca.VND 11,500).**

**Table 12. Price ranges by fish size**

Type of fish	Typical price range per piece (in VND)	
	Fishermen to primary buyers	Middlemen to Farmers/companies
0.5- 5cm (average 1-3cm)	500-1,000	1,000-3,000
5 -10cm (average 5-8cm)	2,000-3,000	3,500-5,000
10 -20cm (average 10-15 cm)		
?? <100g	4,000-5,000	6,000-7,500
?? 100-500g (VND/kg)	40,000-50,000	60,000-70,000

USD 1 = VND 13,000

The primary buyers were mainly middlemen but also nursing farmers, and grow-out farmers. The price has shown an increasing trend year on year, probably related to the



increase in total culture area on the one hand and limited production on the other.

Most seed were purchased for grow-out locally, either directly by farmers, or through middlemen. Other seed was sold by middlemen to exporters who in turn sold mainly to Taiwan and Hong Kong. The latter were usually more than 100g in size, and were mainly “red grouper” *Cephalopholis miniata* (Phan, 1997). Small quantities of seed were sold to Ho Chi Minh City.

In the past, the fishing production of Khanh Hoa met the demand for grouper seed. There was almost no pressure on the seed supply except for the period just after Tet Holidays (Chinese New Year’s days). Recently, the local grow-out farmers had to import grouper seed from neighbouring provinces such as Phu Yen, Ninh Thuan. The percentage of the imported grouper seed was 15% for the 1998 crop.

The government’s target marine fin-fish production for 2010 (820ha of ponds and 800 cages) corresponds to a requirement for approximately 8.3 million seed to produce 4,200mt of fish. This compares with current production of grouper seed of around 200,000 and a production of 140mt. Clearly, current levels of seed production are totally inadequate to meet the targets.

### **Socio-economic benefits**

The average income to collector households from seed collection was VND 720,000 per year (ca 11% of total household income), and return on labour varied between VND10, 906-37,135/person/day, similar to typical agricultural wage rates

In recent years, the number of collectors has decreased because some of them have moved to off-shore fishing activities, which were funded by the central government. The fishermen prefer the new job where they can receive a higher return on labour than that in the collecting seed.

### **Discussion and conclusions**

#### *Status and management of grouper seed habitat*

Poverty, lack of access to alternative livelihoods, and lack of environmental awareness has resulted in over-exploitation of near shore resources, and continuing poverty in coastal areas of Khanh Hoa Province. This trend may have a serious impact on the grouper seed fishery. Recently, many seagrass beds, especially in the Nha Phu lagoon (the most important grouper nursery site), have been heavily damaged by motorised push-nets and trawling nets. Coral reefs have also become over-exploited with significant use of explosives and cyanide. Seaweeds in the Khanh Hoa Sea, especially *Sargassum spp* “forests” have almost disappeared in recent years. This may be related to the over-exploitation of one species of sea-urchin for export, allowing an increase in the population of another. The latter may have over-grazed the *Sargassum* sea weeds. Much mangrove has been destroyed for constructing shrimp farms around Nha Phu lagoon. From 1994 to 1997 approximately 500ha of mangrove was destroyed (Hoa, 1997) out of a total area of 810ha recorded in the years of 1981-1983 (Cho, 1996).

The supply of wild grouper seed to the cage culture industry appears to be unsustainable in the short term and inadequate in the longer term. There are several reasons for this:

- ?? catch per unit effort of seed appears to be in decline;
- ?? catch and catch per unit effort of adult stocks also appears to be in decline;
- ?? nursery and adult habitat (seagrass, mangrove, coral) has been, and continues to be, severely damaged – from habitat conversion, destructive fishing practices, coral extraction and possibly local pollution;
- ?? government targets for cage culture are high (an estimated trebling of cages by 2010);
- ?? stocking densities have shown an upward trend, and this is likely to continue;  
and
- ?? the cost of seed is already high, and is likely to increase, threatening the competitiveness of the grow-out sector, and reinforcing the trend to over-exploitation.

The concentration of seed supply in one lagoon is both an opportunity (in so far as the stock can be identified and awareness raised) and a threat (if habitat quality in this lagoon continues to decline, the impact on grouper aquaculture and capture fishery will be serious).

For the future, hatchery production will be the only way to provide sufficient seed to allow the industry to expand. The high and increasing price of seed should make hatchery production economically viable, despite its technical difficulty.

### **3.3.5 The sustainability of feed supply**

Feed for cage culture (grouper and lobster) is almost exclusively “trash fish”. This raises several issues related to sustainability:

- ?? Use of fresh fish for aquaculture can cause pollution;
- ?? High demand for trash fish from aquaculture could drive up the price and reduce the availability to the poor of a high quality low cost food
- ?? High demand of trash fish for aquaculture could negatively impact other users of trash fish, such as fish sauce manufacturers, livestock producers etc;
- ?? In the absence of effective fisheries management, high demand may lead to over-capitalisation and exploitation of the fishery

These issues were addressed through a comprehensive range of studies.

#### **Activities**

1. Survey of cage farmers to determine:
  - ?? preferred species/type of trash fish;
  - ?? feeding practices;
  - ?? food conversion ratio achieved;
2. Analysis of secondary data and survey of major fish markets to assess the nature and status of the fishery, market prices, and the destination of trash fish produced.
3. Analysis of chemical composition and nutritional qualities of trash species used;
4. Assessment of potential for the development of artificial feeds for both grouper and lobster

#### **Outputs**

##### **The market for “trash fish”**

Aquaculture has become a significant local consumer of trash fish, accounting for 30% of landings, the balance being used for pig and chicken feed (30%), fish sauce

(15%) and a variety of other uses (25%) including human consumption, especially for the poor. Anchovy is the favoured species used for fish sauce and is also exported as a dried product. Most trash fish species cost around VND3, 000 (c.a. US\$0.25/kg).

### **Cage culture diet composition and food conversion efficiency**

Lobsters are fed exclusively with fresh whole or chopped fish and shellfish. The most commonly used species/groups for feeding lobster are Lizard fish (*Saurida* spp); red big-eye (*Priacanthus* spp); Pony fish (*Leiognathus* spp); pomfret; snails, oyster and cockles; small swimming crab, other crabs and shrimp. Finfish comprises about 70% of the diet, with 30% shellfish. The preferred fish (comprising 38% of fishes in diet) was lizard fish. Most trash fish species cost around VND3, 000 (c.a. US\$0.25/kg).

Farmers showed active selection of the preferred fish species, using a consistently higher proportion than present in typical trash fish landings, and using a higher proportion of lizard fish in particular, despite significantly higher price (average VND5000/kg) associated with this species.

Food conversion ratio for lobster using this diet is high at around 28 (fresh weight basis).

In the case of grouper culture, previous studies (Trai and Hambrey 1997) have shown that only whole fresh trash fish are used, and that food conversion ratio in cage culture, averaging 5.9 (fresh weight) is significantly higher than that for pond culture of grouper where average FCR was found to be 4.3. Feed costs comprise around 18% of the farm gate price of grouper. More recent studies (Williams 2000) suggest that FCR for grouper may lie in the range 6-17.

### **Price trends for trash fish and consumption by the poor**

Unfortunately data was inadequate for a thorough analysis of this issue, and the project lacked the resources to undertake a major investigation no trend data was



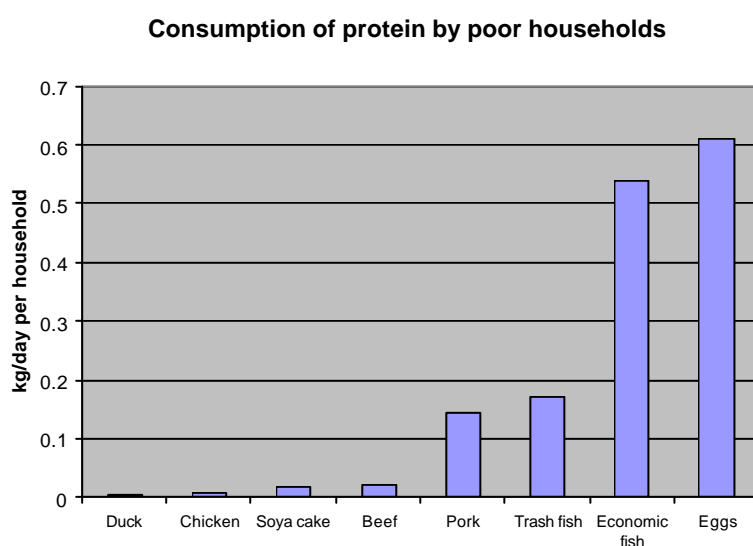
available on the price of trash fish – at least in respect of “preferred species” used for aquaculture.

A survey of 20 of the poorest households in the villages studied (average household size was 5; per capita household income average \$120; range \$51-\$171) was undertaken to establish the role of fish, and in particular low value trash fish in the diet, and perceptions of price change and the main influences on price.

Trash fish is important in the diet, contributing on average 11% of protein (Figure 14). Economic fish (larger more expensive fish, not used in aquaculture) were considerably more important, contributing 36% of protein intake. However, the poorest of the households surveyed tended to use a higher proportion of trash fish and less economic fish. In terms of species of trash fish, lizard fish, preferred for aquaculture, is not popular for household consumption.

In terms of price trends, respondents noted no significant increase in the price of eggs, pork, soya cake, beef chicken, duck and eggs over the last 5 years.

**Figure 14.**

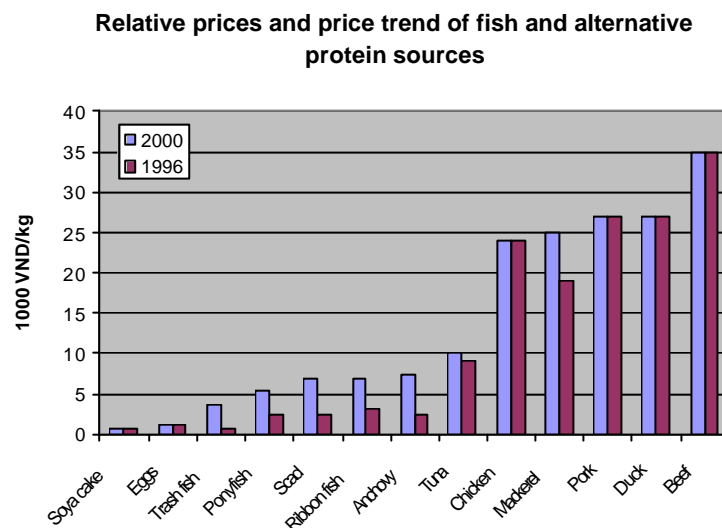


The price of mackerel and tuna has increased modestly, while the price of small fish and trash fish has increased by up to 3 times (Figure 15). The reason for these

increases are due to increased demand for export (especially scad and anchovy) and for fish sauce, aquaculture and pigs (trash fish, ponyfish, ribbon fish). While the relative importance of these different pressures is impossible to gauge accurately, it is notable that ribbon fish – a non-preferred species for cage culture – has increased substantially in price.

To explore the issue further, the respondents were asked to speculate on the reasons for the increased price of fish. 65% rated increased export demand as the most

**Figure 15.**



significant; 35% rated decreased catch as most significant; and 5% rated cage aquaculture as the major factor. Although none rated it as the main cause, currency devaluation was also considered to have contributed to increased price.

Overall we may conclude that demand for trash fish in cage aquaculture has contributed to a significant price increase, but that it is only one of several factors, and probably not the most important. The impact of this increase on poverty and nutrition is again difficult to gauge, but given the importance of fish in the diet may be significant. It is notable that the four households with per capita income less than \$80

all consumed more trash fish than economic fish, and consumed far more trash fish than those with higher income.

### **Sustainability of fishery exploitation**

The government has made and promoted major investment in larger offshore boats. Many of these continue to fish nearshore because of lack of storage facilities. There is no scientific stock management nor any attempt to control fishing effort, which is high. In general catch per unit effort has declined, and the proportion of trash fish has increased. The future sustainability of the fishery is therefore in question.

### **Pollution from cages**

The very high food conversion ratio for lobster (ca 30) and the messy feeding habits of the animals imply very high waste and the potential for serious pollution. In practice this has not been a problem to date, due to the low stocking densities and the high quality of the sites used – typically in locations with good tidal currents and flushing and even sandy bottoms. Visual survey showed no significant accumulations of organic matter beneath the cages.

In the case of grouper the (wet) food conversion ratio of around 6 using whole trash fish corresponds to a relatively high conversion efficiency, similar (on a dry weight basis) to that which would be achieved using dry formulated feeds. Again there are no signs of significant pollution to date.

Notwithstanding the current situation, it is clear that significant further expansion, and the possibility of increased stocking densities (at least for grouper) may result in problems in the future. Both farmers and government are aware of this and have requested advice on environmental capacity.

### Improved feed management and alternative feeds for cage aquaculture

A consultancy study was commissioned with part funding from ACIAR to determine whether trash fish feeds could be used more efficiently for grouper and lobster culture, and whether there more sustainable and cost effective alternatives (Williams 2000). It concludes that in the medium/long term formulated feeds should be developed for both lobster and grouper, and provides outline composition for such feeds (Table 13). In the short term it concludes that trash fish is a rational economic choice, but that food conversion efficiency could be greatly improved with better feed management and guidance on food species selection for optimal growth and FCR. Lobster in particular may need a higher proportion of shellfish in the diet in order to bring FCR down.

**Table 13. Guidelines for the nutrient specification of diets for on-growing of juvenile estuarine grouper (*Epinephelus spp.*) and spiny lobster (*Panulirus spp.*)**

Nutrient	Recommended nutrient specification for compounded diet (~90% DM)	
	Grouper	Lobster
Gross energy (kJ/g)	18 – 23	18 – 19
Digestible energy (kJ/g)	14 – 18	13 – 14.5
Crude protein (g/kg)	420 – 500	450 – 470
Digestible protein (g/kg)	320 – 400	350 – 400
Total lipid (g/kg)	120 – 160	60 – 100
Phosphatidylcholine (g/kg)	?	4 – 10
Cholesterol (g/kg)	?	2
Astaxanthin (mg/kg)	?	30 – 70
Total saturated fatty acids (g/kg)	<50	<30

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Total monounsaturated fatty acids (g/kg)	>50	>30
Total n-3 fatty acids (g/kg)	20 – 25	10 – 20
Total n-3:n6 fatty acids	>1.5; <4:1	>2:1; <4:1

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### **3.3.6 Markets and comparative advantage**

#### **Activities**

The sales and distribution network for grouper and lobster in Vietnam was explored through discussions with farmers, dealers and exporters. In addition, a broad review of markets and production costs for marine finfish worldwide was undertaken in order to gauge long-term potential (Hambrey 2000)

#### **Outputs**

##### **Distribution and marketing within Vietnam**

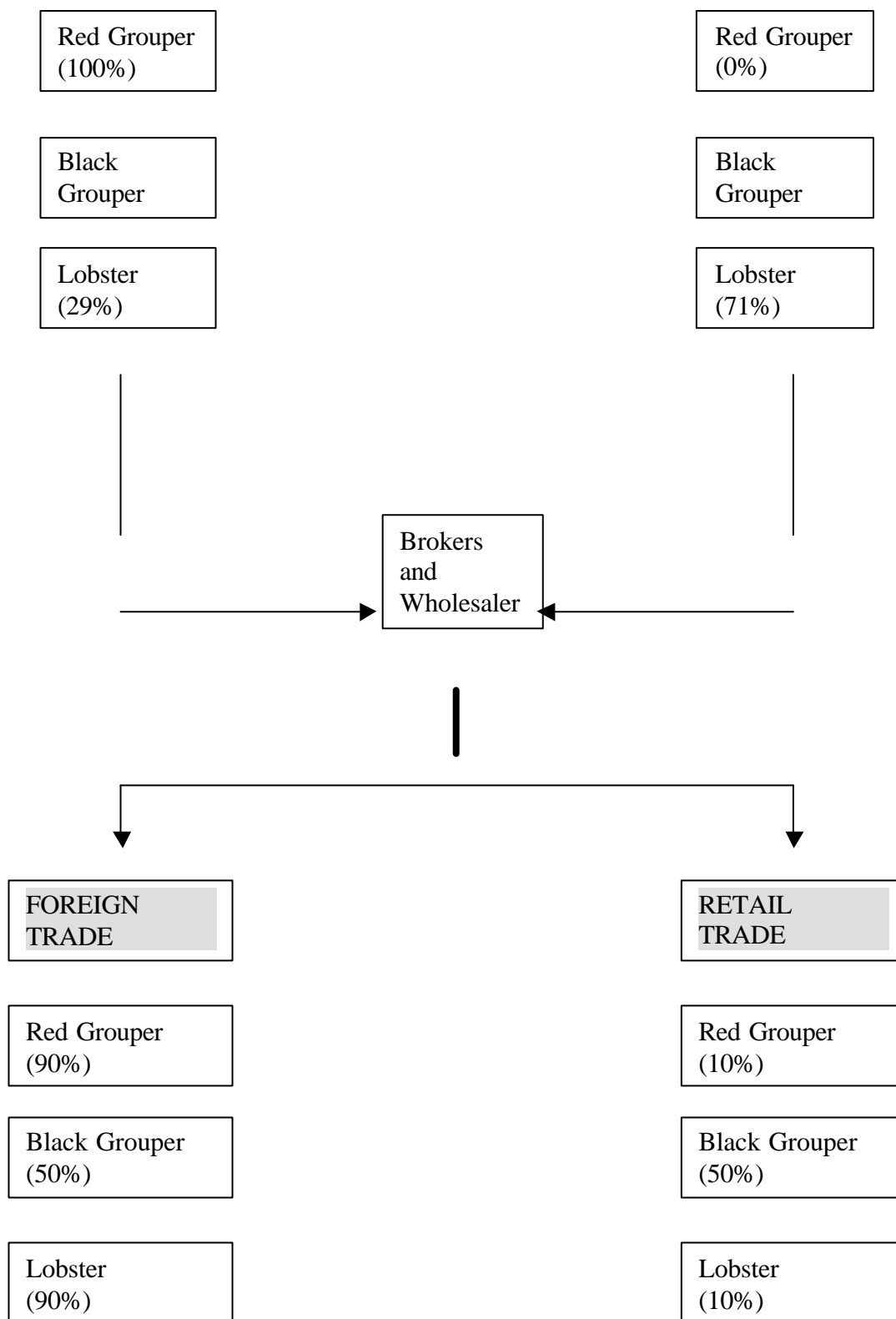
Approximately 150 tonnes of live grouper and 100 tonnes of lobster are transported annually to Ho Chi Minh City from the south coastal provinces. This trade is valued at about five million dollars. Around 60% of grouper and most lobster are re-exported to Hong Kong, China, Taiwan and some other countries, although Ho Chi Minh city and Hanoi are emerging markets for live marine products, especially black grouper.

Khanh Hoa and Binh Thuan provinces are the main suppliers of live grouper and lobster. Khanh Hoa 's products are mainly from aquaculture whereas products of Binh Thuan are almost from fishery.

The Ho Chi Minh city market for live grouper and lobster is separate from the main fish market and is controlled by four wholesalers among whom Minh Phuong and Hoang Ha companies are the main traders holding 71% and 18% of grouper production, and 29% and 35% of lobster production, respectively.

*Fishery Sources*

*Aquaculture Sources*



**Figure 16. Marketing flow of major live marine products in Khanh Hoa province**

Based on a higher producers' share (83%) and lower marketing margin (VND 80 000 and 17%), it is concluded that lobster market was more efficient than that of the grouper markets. This is related to the much higher value of lobster.

**Table 14. Marketing margins and producers' share of consumer price of grouper and lobster in the South Vietnam and Hong Kong in 1997-1998.**

	VND/kg			As % of consumer price		
	Red grouper	Black grouper	Lobster	Red grouper	Black grouper	Lobster
1. Farm/Fishermen price	180 000	70 000	400 000	64	70	83
2. Wholesale price	260 000	85 000	435 000	93	85	91
3. Retail price	280 000	100 000	480 000			
4. Hong Kong price*	700 000	220 000	?			
5. Marketing margin						
?? (3-1): value	100 000	30 000	80 000			
% (3)	36%	30%	17%			
?? (2-1): value	80 000	15 000	35 000			
% (3)	29%	15%	7%			
?? (3-2): value	20 000	15 000	45 000			
% (3)	7%	15%	10%			

(\* estimated from Table "Indicative prices of live grouper and other high value reef fish" (Hambrey, 1997)).

### **Long term prospects, global markets and comparative advantage**

Cage aquaculture of marine finfish is a rapidly growing industry world wide. While the most impressive rates of growth have been for cold-water diadromous fish (mainly Atlantic salmon) there has also been strong growth in production of warm-water species, especially European and Asian seabream and seabass, and to a lesser degree groupers, snappers, and other tropical and sub-tropical species.

Demand is strong and increasing, but single species markets (such as salmon and seabass) have shown vulnerability to rapid increases in aquaculture production. The market for live reef-fish such as groupers is high value and growing, but nonetheless



relatively small at present (a few thousand tonnes, traded mainly through Hong Kong). Transport costs of live grouper are high, and significantly increased aquaculture production is likely to drive farm gate prices down significantly, especially in those countries relatively distant from the major markets of Hong Kong, China and Taiwan. Although Vietnam is relatively well placed in this regard, the small market, especially when compared with Vietnam targets for cage culture production, is likely to cause problems in the not too distant future. In order to survive, cage fin-fish farmers will have to enter a higher volume lower value market of fresh chilled high quality marine fin-fish (such as seabass). Farm gate price for this market – typically around \$3/kg – is substantially lower than current farm gate values in Khanh Hoa, and indeed is lower than current production costs. Significant rationalisation and re-structuring, with greatly increased labour productivity will be required to bring costs down and compete in this market – with implications for employment levels. Currently labour productivity in the salmon industry is approximately 100 times that of small scale grouper culture in Khanh Hoa province.

The international market for live lobster is much greater than that for grouper and the value very high, with steadily increasing demand. Very few countries are able to produce lobster – either because seed is lacking, or because climate and sea-conditions are unsuitable. There is little doubt that central southern Vietnam has a comparative advantage in the production of tropical spiny lobsters (many species, relatively abundant seed, suitable conditions). Unfortunately, wild seed is likely to become limiting (indeed there are signs that it is already limiting) and there is little prospect of hatchery production.

### 3.3.7 Comparative economics and sustainability of cage culture

#### Activities

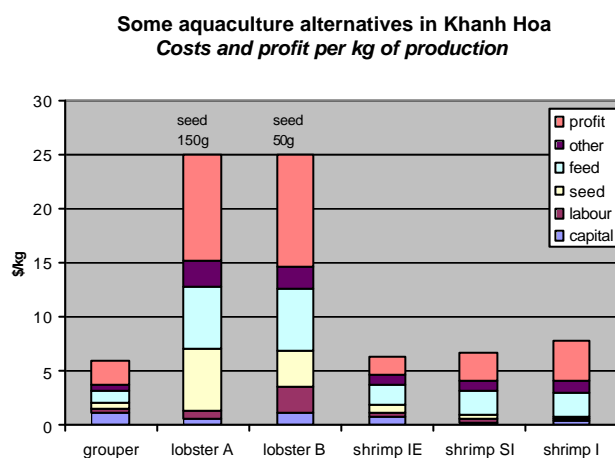
Extended financial analysis was undertaken of the various cage culture systems and existing activities in coastal villages. This analysis generated a range of financial, socio-economic and environmental ratios.

Villagers were questioned as to their perception of the economic strengths and weaknesses of different activities

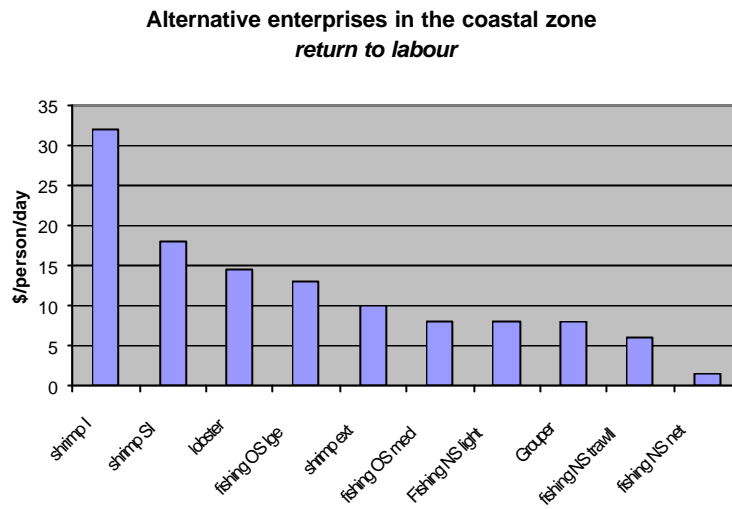
#### Outputs

#### Extended financial analysis

Figure 17.



**Figure 18.**



**Figure 19.**

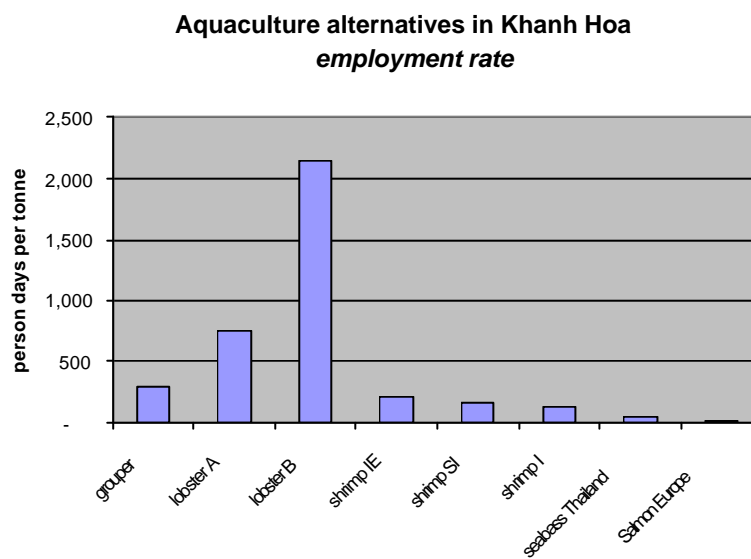


Figure 20.

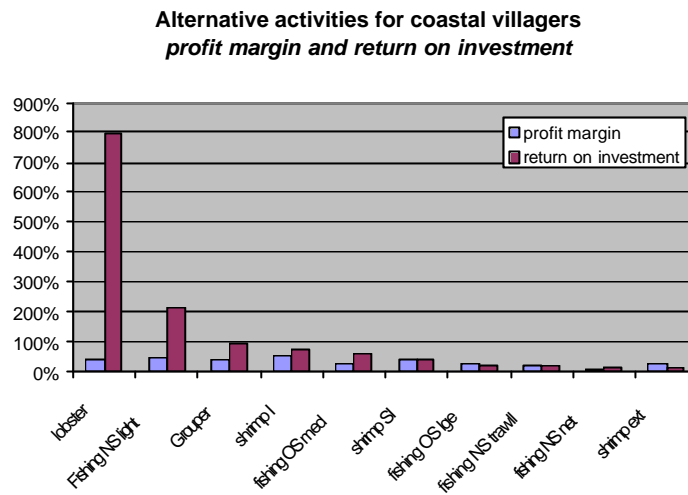
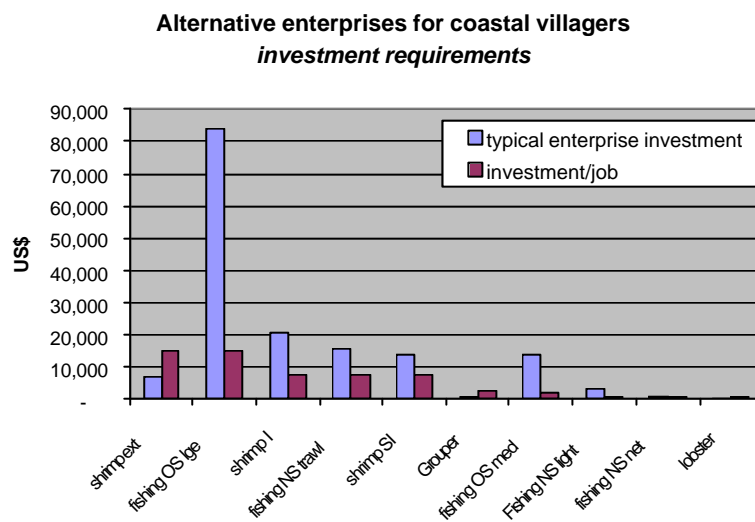


Figure 21.



The following table summarises these indicators to provide an overall indication of financial and economic attractiveness. Cage culture, and especially lobster culture scores very highly compared with alternative activities.

**Table 15. Summary comparison of financial and economic indicators for alternative enterprises in the coastal zone**

\* = unfavourable; \*\* = favourable; \*\*\* = very favourable

	Lobster culture (cages)	Grouper culture (cages)	Semi-intensive shrimp farming	Offshore fishing	Inshore fishing (net)
Profit/kg	***	**	**	na	*
Profit margin	**	**	**	*	*
Return on investment	***	**	**	*	*
Return to labour	***	**	***	**	*
Employment/kg	***	**	*		*
Enterprise (start-up) investment	***	***	*	*	**
Investment/job	***	**	**	*	**

### **Villager perceptions of social/economic strengths and weaknesses**

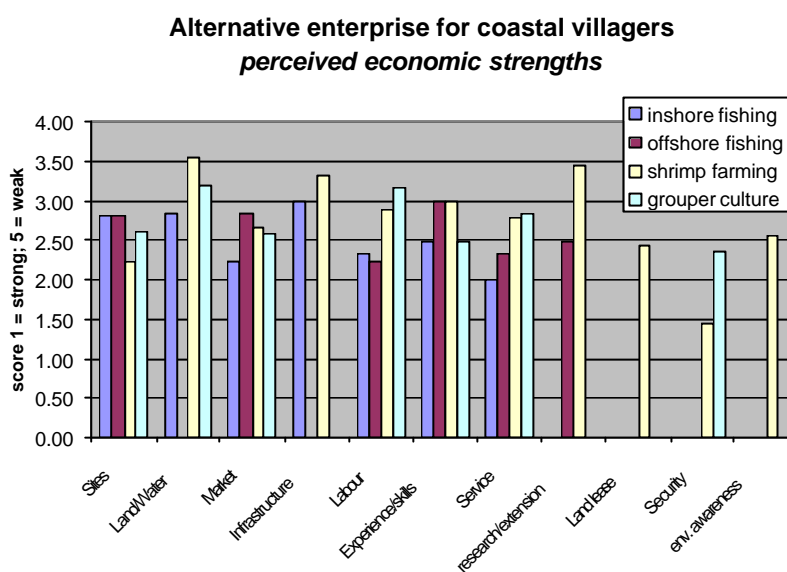
Households were questioned about the strengths and weaknesses of different enterprises in economic terms. The criteria agreed (although not all were relevant to all activities) were:

1. Site availability;
2. Quality of land/water;
3. Strength of market/product value;

4. Availability of suitable labour and skills;
5. Experience
6. Available services
7. Security issues

The results are summarised in Figure 22.

**Figure 22.**



Based on these analyses a set of profiles of alternative aquaculture activities has been developed as a basis for discussion with potential farmers.

### **3.3.8 Summary**

Cage culture of lobster and grouper has developed rapidly in recent years, and many poor people are keen to enter the business. The government has set ambitious targets for aquaculture development including cage culture.

The main purpose of the Vietnam research was to establish whether or not cage culture was a suitable activity for the poor, whether it is sustainable, and if so, what would need to be done to facilitate entry by the poor and enhance their chances of success.

A range of approaches and methods were used including RRA, PRA, socio-economic survey, habitat survey, economic and market analysis and institutional analysis.

Many poor people in coastal villages in Khanh Hoa province, Central Vietnam, are trapped in poverty, constrained by lack of capital, lack of land, and lack of education. They are suffering from declining returns from the traditional activity of inshore fishing - due to high population pressure, over-exploitation and use of destructive methods and gears. Aquaculture represents a possible solution.

Cage culture (of spiny lobster and grouper) is very attractive from a financial and economic perspective, and has several features, which make it ideally suited to poor people. It requires no land and only modest start-up capital, and it generates very high returns on labour and investment compared with most alternative activities. It also generates high levels of employment (per unit production; per unit area). To date (unlike shrimp farming) it has been relatively free of disease, and is perceived as low risk. The market outlook for lobster culture is excellent, with a large and buoyant international market. Prospects for grouper are less good, with a smaller market for live fish, but Vietnam is relatively well placed to supply this market, and it is likely to expand modestly.

Unfortunately, despite these strengths, the sustainability of cage culture is questionable on several grounds. Grouper and lobster culture are both dependent on wild seed. Grouper seed is caught in relatively few key nursery sites, and these sites are suffering habitat degradation. It is very unlikely that existing supplies will be able to meet the demands of significant expansion. Hatchery production of groupers is possible but difficult, and will in any case take several years to develop. Very little is known about the lobster seed fishery, but there are already signs of over-exploitation, and again, it is very unlikely that existing supplies will serve an expanding industry. Hatchery production of spiny lobsters is extremely difficult and very unlikely in the foreseeable future. Improved management of both seed and adult fisheries may help to ensure sustainability of a modest fishery, but fisheries management capacity is extremely weak. Cage culture of grouper and lobster, while having excellent characteristics for poor people, is likely to be constrained by seed supply at some point in the not so distant future.

Possible alternative species include seabass (*Lates calcarifer*), Kopia (*Rachycentron canadum*) and rabbitfish (*Siganus spp.*). Cage culture of seabass is now well established in other countries in the region (Thailand and Taiwan) with hatchery production of seed relatively straightforward. Unfortunately market demand is as yet low in Vietnam, and farm-gate price is currently less than US\$2. Although the price is likely to rise as the urban economy grows, as has happened in other countries in the region, the margins will be slim and high labour productivity will be required for success. This implies more efficient larger scale enterprises, and is therefore less suitable as family business for poor people.

Kopia is a very interesting fish with good growth characteristics, high farm gate value, and established hatchery technology. At present it represents the most likely candidate for cage culture in the long term. Rabbit fish culture also shows promise but is at a less advanced stage in terms of hatchery production.

There are also questions relating to the use of trash fish in cage culture. Although supplies are plentiful at present, price is rising quite rapidly, suggesting that demand – for export, for fish sauce, for animal husbandry, for aquaculture and for human



consumption - is outstripping supply. Not only does this have implications for the costs of this input to aquaculture, it also raises questions about possible secondary impacts on nutrition among the very poor that consume significant quantities of trash fish themselves. Although there are differences between the species used for human consumption and those used for aquaculture, there is probably some cross-over.

A second concern relates to the waste from inefficient use of trash fish food resources. Although many grouper farmers achieve relatively good FCR (around 6 on a wet weight basis) many are less efficient. Current uses of trash fish and shellfish for lobster culture is far less efficient, with FCR close to 30. This has implication for both resource use efficiency and pollution. At present the latter is not a problem with cages well sited and typically using low stocking density. However, in the long term this will undoubtedly become a problem, at least locally, and the development of formulated feeds from local materials should be a research priority.

Finally, although disease has not been a problem to date, it is very likely that it will become so as the density of cages increases, and this could have serious impacts on new entrants from a poor background.

### 3.3.9 Contribution of outputs

The contribution of activities to results and outputs is summarised in Table 16.

**Table 16. The contribution of activities to results and outputs**

Output	Associated activity	Contribution of results
A comprehensive multidisciplinary literature review of small scale cage culture in inland and coastal areas of Asia submitted for peer review publication	<ol style="list-style-type: none"> <li>1. Review of existing literature;</li> <li>2. Rapid appraisal of existing marine cage culture in Vietnam</li> </ol>	A review of marine cage culture in Vietnam has been completed and was presented at the 1 <sup>st</sup> International Symposium on Cage Culture in Asia, Tungkang, Taiwan, November 1999.. The review has been published in a special edition (peer reviewed) of Journal of the Asian Fisheries Society
Local sector reviews completed for seed and feed sources for cage culture	<ol style="list-style-type: none"> <li>1. Seed fisherman survey;</li> <li>2. Seed nursery habitat survey;</li> <li>3. Trash fish use as aquaculture feed and quality analysis;</li> <li>4. Trash fish landings and market survey</li> <li>5. Fish consumption survey</li> </ol>	Seed supply is probably not sustainable in the medium/long term; hatchery production of finfish will be required. Hatchery production of lobster not feasible. trash fish use effective and acceptable in the short and medium term, but not in the long term.
Assessment of sustainability of alternative mariculture species	<ol style="list-style-type: none"> <li>1. Financial analysis;</li> <li>2. Economic analysis;</li> <li>3. Market assessment</li> <li>4. Risk analysis;</li> <li>5. Constraints analysis</li> </ol>	Cage culture of grouper, lobster very attractive from all financial/economic perspectives; Expansion of lobster culture limited by seed supply; Expansion of grouper culture limited by seed supply, but hatchery production feasible in long term; Switch to seabass possible (hatchery seed relatively straightforward) but returns low because of low labour productivity; Culture of <i>Rachycentron</i> shows high potential – seed, feed, markets not constraints
Understanding of constraints and socio-economic conditions of poor local people	<ol style="list-style-type: none"> <li>1. RRA</li> <li>2. PRA</li> <li>3. Socio-economic survey</li> <li>4. Livelihoods analysis</li> </ol>	Improved livelihoods of poor constrained by lack of land and degraded inshore fisheries; Widespread interest in aquaculture; For entry and success need low interest credit available over adequate period; Quality of life and outlook for existing cage farmers positive compared with shrimp farming and inshore fishing

#### ***4. Planning and extension guidelines for small-scale cage aquaculture***

**Output 3 focuses on small-scale cage aquaculture development throughout Southeast Asia. It combines knowledge derived from Bangladesh and Vietnam (Outputs 2 and 3) to form generic guidelines applicable to marine and inland cage operators.**

##### **4.1 Background**

The project has explored the potential of small-scale cage aquaculture as a tool for poverty alleviation through a wide range of methodological approaches, including participatory rural appraisal, on-station and on-farm trials, social, economic and environmental appraisal. We have concluded that in both Bangladesh (mainly freshwater) and in Vietnam (marine) small scale cage culture has significant potential for poverty alleviation, although there are some environmental constraints.

In order to promote the sustainable uptake of cage technologies, planning and extension guidelines for small-scale cage aquaculture were formulated, as outlined in the project logical framework (Appendix I). They comprised the following components:

- ?? *guidelines* for the production of low-medium input, low-high output cage culture extension and training materials;
- ?? *guidelines* for planners, policy makers and development specialists to assess the potential for cage culture within particular social, economic and institutional environments and improve the selection of technological options.

##### **4.2 Activities**

A regional workshop on research and development strategies for small-scale cage culture was conducted from the 9<sup>th</sup>-11<sup>th</sup> of July 2000 attended by 46 delegates, including project R7100 staff, development workers and government representatives

from Bangladesh, Vietnam, Stirling and AIT. Here, key issues in cage aquaculture were discussed in the context of the different technical, institutional, social and physical environments of inland and marine systems.

Through a combination of group work and plenary discussion guidelines were achieved for assessing cage aquaculture potential and identifying development options for small-scale cage culture. A review of tools and methodology used in Project R7100 was also carried out and policy initiatives for sustainable cage culture development formulated (Appendix VII).

### **4.3 Guidelines for the production of small-scale culture extension and training materials**

A key conclusion was that in order for low/medium input, small-scale cage culture research and extension to be effective, close linkage and collaboration with relevant institutions and potential beneficiaries is paramount. Project R7100 had experience with several institutions in both project locations and as consequence had access to endemic knowledge, increasing both the speed of research and the identification of key constraints of uptake to beneficiaries. The use of in-built promotional pathways and the participatory nature of the research meant that access to the rural poor was readily achieved and research could work alongside and (in the case of Bangladesh) be conducted by, its potential beneficiaries. This meant that not only was the technology more likely to be refined to their needs, but those participating were exposed to cage culture, increasing their level of experience. The collaboration with partner institutions also assists in the training of institutional staff and the more rapid dissemination of findings.

The approach adopted by project R7100, however, had certain limitations that became apparent during the course of the research (Table 9). The use of participatory approaches is limited by financial and time constraints, and by the level of experience of stakeholders. However, results are less quantitative in nature than those generated by more rigorous and controlled scientific experimentation and survey.

Despite these problems the combination of research with an on-going development project appears to be both effective and appropriate for developing and refining technologies and for the production of extension materials. It allows for rapid identification of constraints and adaptation of research in line with the needs of beneficiaries, and the practicalities of making a living from aquaculture. As a result, the quality of research and its associated outputs are increased.

#### **4.4 Guidelines for the assessment of cage culture potential.**

In addition to the partnership between research and other institutions, the key to assessing the potential for cage culture is a consideration of the social, economic, institutional and environment context of intended beneficiaries. During the project workshop it was concluded that the most appropriate practical mechanism of achieving this was through the production of a checklist to aid assessment of cage culture potential, cage culture profiles and decision trees

The checklist serves as the basis for discussion between the extension worker and the potential beneficiary about how cage culture might meet his/her needs and aspirations. If it is concluded that cage culture is a potentially important development option, cage culture portfolios (profiles of different forms of cage aquaculture) can be introduced and considered.

The tools should serve as a *guide only*. They should be reviewed and modified by practitioners, as situations and priorities vary both between regions and individual farmers.

#### **4.5 Summary**

The project has generated a set of guidelines for the promotion of appropriate and sustainable development of cage aquaculture. These include:

1. A checklist designed to serve as the basis for discussion between extension workers and farmers on the potential of cage culture to meet his/her needs;

2. A set of profiles of different forms of cage culture, which can be presented as a "menu" should cage culture, be considered to be appropriate.
3. A generic decision tree, which may be further developed by the farmer/extension worker as a framework for decision making

These tools should be assessed critically and adapted to local needs as appropriate.

#### **4.6 Contribution of outputs**

The products from this workshop serve as useful guides for similar research projects and outline the advantages and constraints associated with the approach adopted by R7100. The production of materials to assess cage culture potential serve as useful sources of generic information for future policy planners, extension workers and development workers concerned with small-scale cage culture development.

## 5. Summary

?? Project R7100 addressed three main outputs, in two project locations Bangladesh and Vietnam.

1. *The current status and characteristics of small-scale cage aquaculture.*
2. *The technological, economic, social and institutional context of small-scale cage aquaculture*
3. *Planning and extension guidelines for small-scale cage aquaculture.*

?? The assessment of the current status and characteristics of small-scale cage aquaculture demonstrated the main issues facing the development of these systems to be of benefit to the rural resource poor in Asia. Despite the differences between the two countries, a lack of knowledge of the range of alternatives, and the social, economic and environmental characteristics of specific technologies were perceived as significant constraints in both, as was uncertainty of success when compared to the more traditional livelihood strategies.

?? Through the use of case studies, technology evaluation and participatory impact monitoring the technical, social, economic and institution contexts and the role of small-scale cage culture in poverty alleviation has been identified. Cage culture has been demonstrated to be a viable livelihood for the rural resource poor which facilitates the participation of women, although less so in the more religiously conservative regions of Asia. However the level of risk involved in '*traditional*' cage culture practises is significant enough in some areas to deter many from participating and hence the use of reduced risk options may be more suited to the socio-economic context of beneficiaries. The impact of cage culture presently remains positive with farmers and communities attributing benefits rather than negative associations to its implementation. It is therefore critical that there is not an uncontrolled expansion of cage culture and that the situation is monitored and controlled by development, government or community organisations.

- ?? When considered together these two outputs assist in the generation of a set of guidelines for the promotion of appropriate and sustainable development of cage aquaculture.
- ?? Key to this is a participatory approach to research with existing institutions utilising in-built pathways for the identification of research topics and dissemination of research findings. To increase the quality of the outputs and to add value to the research process a greater degree of linkage should be sought as this increases both the amount of knowledge available and number of beneficiaries reached. The level of linkage is also critical in attempting to affect policies concerning small-scale cage culture at the NGO development or government level.
- ?? Guidelines for planners, policy makers, and development specialists, to assess potential for low-input, low-output cage culture within social economic and institutional environment, and improve selection of technological options have been produced. These take the form of a checklist for aquaculture potential, cage culture profiles and decision trees serving as a basis of discussion between farmers and extension workers. These are not a definitive guide covering all small-scale cage culture in Asia but rather serve as a basis for discussion that can be used to generate guidelines which can be adapted to particular regions, situations and individuals. The process allows decisions to be made on whether cage culture is appropriate or not and to choose the most appropriate system.



## **6. Contribution of outputs**

- ?? The combination of research and development institutions can be described as mutually beneficial, with the linkage between project institutions resulting in an increased speed of research, refinement of cage technology and capacity building than would have occurred in isolation of the development organisation. Through the aforementioned three main outputs of Project R7100 the rural resource poor and women have been benefited (Table 17).
- ?? In both locations prior to the assessment of the current status of cage aquaculture in both project locations little was known, the findings of this output now serve as a important reference point both for the project and future cage aquaculture ventures. It is from these reviews that the key issues concerning the use of cage aquaculture in benefiting the rural resource poor were identified and subsequently addressed by R7100.
- ?? The assessment of the key technical, economic, social and institutional contexts of small-scale cage culture has led to an increased understanding concerning small-scale cage aquaculture and a valuable reference source. Further to this, due to the collaborative nature of the project and the utilisation of the in-built promotional pathways has led to an on-going uptake of the research results by the intended beneficiaries. These comprise of two main components i) capacity building of institutions and beneficiaries; and ii) guidance on technology selection and management.
- ?? Finally these serve in the formulation of generic guidelines for the utilisation by policy planners and extension officers applicable throughout south-east Asia.
- ?? In Bangladesh project impacts manifest themselves as the incorporation of R7100 findings in cage culture technology and activities (Table 17). Due to the collaborative nature of the project it is difficult to disentangle and identify whether particular impacts are due to one particular partner. This seems unlikely; rather they are a result of the collaboration of partner institutions sharing resources and

increasing the generation and dissemination of new knowledge. In Vietnam immediate impacts were never anticipated except in terms of local research capacity building (Table 17), since the objective of the project was to provide a sound basis and direction for future research, extension, and promotion of aquaculture development.

**Table 17. Contribution of R7100 outputs to the rural resource poor.**

	Target Group	Numbers	Message to Disseminate	Means of Dissemination	Type of Uptake	Evidence of Uptake (Impact)
<b>Bangladesh</b>	The rural resource poor; women in particular	Currently over 4000 households, 58% women, >100 households involved in hapa rearing technology	Greater economic security through cage aquaculture	?? Farm trial catalogues distributed to 6 regional TOs and 49 PNGOs and APNGOs, ?? Training of regional TOs and NGO staff, approx 50. ?? Pamphlets (hapa rearing) 10 000 distributed. ?? Papers and articles produced and published. (25, including those in prep.)	Inclusion of R7100 findings in cage systems	No of households participating in cage culture systems increasing.  58% female participation  Over 100 households currently involved in hapa rearing
<b>Vietnam</b>	1. The coastal rural poor	17 coastal villages directly; most coastal villages in S Central Vietnam indirectly.	Suitability of cage aquaculture to meet livelihood objectives: means of access	?? Participatory rural appraisal ?? Commune and village level meetings ?? Booklets with simple resource and financial profiles of alternative cage	Building the capacity of local coastal people	Enhanced capacity of local people to assess the suitability of cage culture to meet their needs, and the nature of constraints to entry and success.

Contribution of Outputs

				culture options.		
	2. District/provincial government		Economic potential, sustainability, suitable locations, and suitability for poverty alleviation of marine cage culture; local strategy for the development of sustainable marine cage culture	<p>?? Provincial workshop with national participants on project results and development strategy;</p> <p>?? Workshop proceedings published and distributed to all relevant local and national government departments and institutions (English and Vietnamese versions)</p> <p>?? Booklets with simple resource and financial profiles of alternative cage culture options given to all relevant institutions and organisations</p> <p>?? Press articles and radio programmes</p> <p>?? Research papers and semi-popular articles for regional and</p>	Building capacity of research, extension and planning services	<p>Research and extension workers gain broader understanding of beneficiary needs and nature of aquaculture and alternative development options;</p> <p>Research and extension workers do not “promote” aquaculture technologies, but jointly appraise aquaculture against a range of livelihood options;</p> <p>Sustainable aquaculture development strategy for Khanh Hoa Province and sustainable aquaculture management plans for key aquatic systems now being developed. Project outputs being</p>

*Contribution of Outputs*

---

				for regional and international journals		used as basic resource documents.
<b>Joint</b>	The rural resource poor of Asia	> 9000 households	Guideline for the planning and extension of small-scale cage culture in Asia	?? End of project workshop attended by representatives of all research and partner institutions.	By partner institutions, planners and policy makers during the decision making process concerning small-scale cage culture	Use of project outputs in regional training course on planning for sustainable coastal aquaculture development Use of workshop outputs by extension workers, planners and policy makers.  Increase in the number of sustainable systems promoted

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***Project R7100, Technical Report: The Improved Management of Small-Scale Cage Culture in Asia.***

***Appendices.***

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<b>VI.</b>	<b>Extension and training materials</b>	<b>Page lvii</b>
	The hapa breeding of tilapia ( <i>Oreochromis niloticus</i> )	
	This leaflet is not available electronically, but can be obtained in hard copy format from the Project Leader.	
<b>VII.</b>	<b>Final Workshop report</b>	<b>Page lix</b>

This document is an output from a project funded by the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

## ***I. Logical Framework of Project R7100***

1.1.1.1.1 Hierarchy of Objectives	1.1.1.1.2 Objectively verifiable indicators	1.1.1.1.3 Mean of Verification	1.1.1.1.4 Important Assumptions
<p><b>Goal</b> Sustainable yields from small scale extensive, semi-intensive and intensive aquaculture systems increased through improved management.</p>	<p>By 2005, in target regions of four core/niche countries where demand exists:</p> <ul style="list-style-type: none"> <li>- No. of small scale fish farmers increased by 20%.</li> <li>- Real value of benefits from small-scale fish production incr. Against 1995 baseline by 20%.</li> <li>- Yield/hectare in one targeted extensive system increased by 100%.</li> <li>- Yield of fish from one irrigation system where demand exists increased by 50%.</li> <li>- Fish production from multiple-use ponds on small scale mixed farms in one targeted semi-arid area increased by 20%</li> </ul>	<ul style="list-style-type: none"> <li>- Reports of target institutions.</li> <li>- National production statistics.</li> <li>- Evaluation of aquaculture programme.</li> <li>- Research programme reports.</li> <li>- Monitoring against baseline data.</li> </ul>	<ul style="list-style-type: none"> <li>- Climatic conditions remain favourable.</li> <li>- Enabling environment (policies, institutions, markets, incentives) for the widespread adoption of new technologies and strategies exists.</li> </ul>
<p><b>Purposes</b> The purpose is to develop sustained small-scale cage fish culture in inland and coastal waters through the understanding of the social, institutional and resource environment of resource poor groups. Identifying appropriate technical opportunities, and development approaches for these contexts.</p>	<p>By 1998 , key locations/constraints identified re: productive resources and social factors; criteria defined for small scale cage culture in inland and coastal waters</p> <p>By 1999, management strategies identified and applied in selective locations/production systems.</p>	<p>Reports, peer review publications, extension materials and guide books, workshop proceedings, use in target locations/communities</p>	<ul style="list-style-type: none"> <li>- Target institutions support strategic planning initiative</li> </ul>
<p><b>Outputs</b> 1. The current status and characteristics</p>	<p>1. By march 1999 a comprehensive multidisciplinary literature review of small scale cage culture in inland and coastal areas of Asia submitted for</p>	<p>Review accepted for peer review publication.</p>	

<p>of the small scale cage aquaculture sector in Asia assessed</p> <p>2. Technological, economic, social and institutional context for small scale cage aquaculture development assessed for two regional locations.</p> <p>3. Guidelines for planning and extension of small scale cage aquaculture produced.</p>	<p>coastal areas of Asia submitted for peer review publication.</p> <p>1.1.1.1.4.1.1 2.1 Bangladesh: by end of project, reports on selected case studies, technology identification and testing activities, participatory impact monitoring and evaluation produced.</p> <p>1.1.1.1.4.1.2 2.2 Vietnam: by end of project local sector reviews completed for seed and feed sources for cage culture, and assessment of sustainability of alternative mariculture species completed (Masters theses). By end of project institutional analysis and PRA with farmers / communities completed (Masters Theses).</p> <p>1.1.1.1.4.1.3 3 By end of project guidelines for planning and extension of small scale cage aquaculture produced.</p> <p>4 By end of project workshop conducted with partner institutions in one of project locations.</p>	<p>Reports produced, and publishable material made available for production of peer review publications.</p> <p>Masters Theses produced and accepted.</p> <p>Guidelines produced in the form of a short manual for wider dissemination</p> <p>Edited workshop output. Produce wider promotional and dissemination material.</p>	<p>Partner institution in Bangladesh able to provide required staff inputs and in country funds to implement the activity</p> <p>Suitably experienced local consultant (Bangladesh) can be recruited to support participatory M&amp;E development activity</p> <p>Additional funds to support UK staff travel workshop attendance and production of dissemination material will be available from other sources.</p> <p>Additional funds for staff time to produce final output of dissemination material (published papers and planning guidelines)</p>																				
<p><b>Activities</b></p> <p>1. A review of small-scale cage culture to define the multidisciplinary context, define key parameters,</p>	<table border="1"> <tr> <td>1997/98</td> <td>1998/99</td> <td>1999/00</td> <td>TOTAL</td> </tr> <tr> <td>Staff Costs</td> <td>11375</td> <td>23237.5</td> <td>20225</td> </tr> <tr> <td>Overheads</td> <td>3510</td> <td>6075</td> <td>5927.5</td> </tr> <tr> <td>Capital Equipment</td> <td>3840</td> <td>0</td> <td>0</td> </tr> <tr> <td></td> <td></td> <td></td> <td>3840</td> </tr> </table>	1997/98	1998/99	1999/00	TOTAL	Staff Costs	11375	23237.5	20225	Overheads	3510	6075	5927.5	Capital Equipment	3840	0	0				3840	<p>Quarterly, annual and final progress reports plus final report.</p> <p>Quarterly financial statements of</p>	<p>Funds forthcoming.</p> <p>Visas, access and co-operation forthcoming from authorities, target institutions and</p>
1997/98	1998/99	1999/00	TOTAL																				
Staff Costs	11375	23237.5	20225																				
Overheads	3510	6075	5927.5																				
Capital Equipment	3840	0	0																				
			3840																				

<p>performance indicators and identify target issues in both Bangladesh and Vietnam. This will be based on existing published information, including project documentation of partner institutions, interviews with secondary stakeholders in study regions (including project staff, government departments, and relevant NGOs).</p>	<p>Overseas Travel 4275 7525 7525 19325 Miscellaneous 2000 6500 9500 18000 VAT  TOTALS 25000 43337.5 44977.5 113315</p>		<p>end user groups.  Social, economic and natural environment is conducive to the development of sustainable integrated aquaculture strategies.</p>
<p><b>1.1.2 Bangladesh</b> 2. Case studies to examine the technological, economic, social and institutional aspects of current and potential small- scale cage culture developments. 3. Technology identification and testing: In collaboration with participating farmers and CAGES research staff, assess the potential viability of a range of</p>			

<p>technological options for low input cage aquaculture suitable for resource poor households in rural Bangladesh.</p> <p>4. Participatory impact monitoring and evaluation methods development and testing.</p> <p><b>1.1.3 Vietnam</b></p> <p>5. An assessment of the costs and sustainability of seed supply to marine cage culture in Khanh Hoa Province.</p> <p>6. Rapid appraisal of all relevant institutions. A comprehensive institutional analysis carried out.</p> <p>7. Participatory rural appraisal with cage farmers and the communities in which they are based.</p> <p>8. Review of costs and sustainability of current and potential feed sources for a range of species.</p> <p>9. Assessment of comparative economics, resource profiles,</p>			
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<p>and overall sustainability of alternative species for cage mariculture. This will include comparison with brackish pond culture of grouper, shrimp and crab.</p> <p><b>In conjunction with partner institutions in Bangladesh and Vietnam further outputs include:</b></p> <p>10.A regional workshop in research and development strategies for small-scale cage culture.</p> <p>11. Guidelines for the production of low input low output cage culture extension and training materials.</p> <p>12. Guidelines for planners, policy makers, and development specialists, to assess potential for low input low output cage culture within social economic and institutional environment, and improve selection of technological options.</p>			
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## ***II. Project Proposal***

**RDI**  
**(12/96)**

**DEPARTMENT FOR INTERNATIONAL DEVELOPMENT**

**STRATEGY FOR RESEARCH ON RENEWABLE NATURAL RESOURCES**

DFID Project Number (*to be completed*  
*by NRDD*)

*File Number*

***Project Title***

1. Improved management of small scale cage culture systems.

Abbreviated Title: Small scale cage culture in Asia

**RESEARCH AND DEVELOPMENT  
FUNDING APPLICATION  
AND  
PROJECT MEMORANDUM FORM**

**Note: THE FORM MUST BE COMPLETED TAKING INTO ACCOUNT THE NOTES ON COMPLETION OF ODA PROJECT MEMORANDUM FORMS.**

**PROJECT HEADER SHEET**

COUNTRY

FILE REF:

PROJ TITLE (MAX 60 CHARS):

PROJECT DESCRIPTION- WHAT PROJECT IS DESIGNED TO ACHIEVE (MAX 3 LINES);

-----COMMITMENT (£)---

-----

ODA FINANCIAL AID:

ODA TC:

MIS CODE	TOTAL COSTS	LOCAL COSTS

IS PROJECT COFINANCED WITH OTHER DONARS? (Y OR N):

IF YES, ENTER TOTAL PROJECT VALUE:

--	--

PERIOD OF DFID FUNDING

FROM

TO:

ECON SECTOR CODE:

ESC DESCRIPTION

**POLICY MARKERS** (mandatory for projects over £100,000)

**Priority Objectives**

- 01 ECONOMIC REFORM
- 02 ENHANCING PRODUCTIVE CAPACITY
- 03 GOOD GOVERNMENT
- 04 DIRECT ASSISTANCE TO POOR PEOPLE
- 05 HUMAN DEVELOPMENT-EDUCATION
- 06 HUMAN DEVELOPMENT- HEALTH
- 07 HUMAN DEVELOPMENT- CHILDREN BY CHOICE
- 08 WOMEN IN DEVELOPMENT
- 09 ENVIRONMENT

**Other Markers**

- 10 COMBATING ILLICIT DRUGS
- 11 HIV/AIDS
- 12 URBAN DEVELOPMENT
- 13 PRIVATE SECTOR DEVELOPMENT
- 14 TECHNOLOGY DEVELOPMENT & RESEARCH

**Rio Markers**

- 15 ENERGY EFFICIENCY
- 16 SUSTAINABLE FOREST M'GMENT
- 17 BIODIVERSITY
- 18 SUSTAINABLE AGRICULTURE

**ASSOCIATES** (mandatory for food aid, disaster & refugee relief, JFS)

- MANAGING AGENT(S) :
- PROCUREMENT AGENT(S) :
- COFINANCIER (S) :
- NGO (S) JOINTLY FUNDED :
- EDUCATION LINK/PARTNER :

TYPE OF ENVIRONMENTAL ASSESSMENT (IS, EA, EIA) :

DATE ENVIRONMENTAL ASSESSMENT COMPLETED :

APPROVAL DATE:

APPROVAL LEVEL:

DATE PROJECT DOCUMENTS SIGNED:

I approve this project as described in this document and confirm that the commitment, economic sector, policy markers and associates have been checked for accuracy in line with the PIMS guidance.

Signed \_\_\_\_\_ Name \_\_\_\_\_ Date \_\_\_\_\_

**SECTION A: KEY INFORMATION**

**1. Project Title**

1. Improved management of small scale tropical cage culture systems in Asia
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Abbreviated Title:

Small scale cage culture in Asia
----------------------------------

**2. Is the research strategic/adaptive? (delete as appropriate)**

3. **Project summary** (maximum 100 words)

A major constraint to the development of small-scale cage fish culture by poor communities is the lack of appropriate technologies suitable for the social, institutional, resource and environmental context. By examining a number of current cage culture activities in Bangladesh and Vietnam, the project aims to improve

4. **Keywords** (including subject, species, countries etc.)

Fish cages, inland water, coastal, smallholder, landless, Vietnam, Bangladesh, aquaculture, carp,

5. **RNRRS Programme**

ARP2 Aquaculture management, Aquaculture Research

6. **RNRRS Production System**

7. **Project Goal** (include RNRRS Programme Purpose where appropriate)

Sustainable yields from small-scale semi-intensive and extensive aquaculture systems increased through improved management.

8. **Geographic Focus**

SE ASIA

9. **Commodity Base**

Fish

**SECTION A: KEY INFORMATION** Continued

10. **Applicants full name, title, post held and department**

Dr. M.C.M. Beveridge, Senior Lecturer, Institute of Aquaculture, University of Stirling  
Dr. J. Alan Stewart, Research Fellow, Institute of Aquaculture, University of Stirling  
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Agricultural and Aquatic Systems  
Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathum Thani, 12120,

11. Name and address of any collaborators

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**Fax: 02 814183**

Dr Nguyen Trong Nho  
University of Fisheries,  
Nha Trang,  
Vietnam

12. Project Location

DFID?CARE CAGES PROJECT Locations, Bangladesh

Kanh Hoa Province, Vietnam

13. If the project is located overseas or if there is an overseas collaborator, has the approval of the overseas government been obtained? If so, provide details.

No

14. Starting and finishing dates

April 2000

January 1998



Section B: **DEMAND, UPTAKE AND GEOGRAPHICAL FOCUS**

15a What is the project's purpose (maximum 50 words)?

The purpose is to develop sustained small scale cage fish culture in inland (Bangladesh) and coastal (Vietnam) waters through the understanding of the social, institutional and resource environment of resource poor groups. Identifying appropriate technical opportunities and development approaches for these contexts

15b. What developmental problems or needs is the project aimed at?

While a range of small-scale cage culture systems is technically feasible in the tropics, their development has been limited by the complexity of the development context. Factors relate to both the production environment and to the social, cultural and institutional environment (e.g., water resource availability, control of use and potential use conflict, other resources availability, current uses and use priorities, local communities' attitudes to alternative management and access to institutional support in the form of knowledge). There is a need to identify approaches to the development of technological options, which take account of this context, to enable development

15c. What is the evidence for the demand for the research?

**DFID Regional Priorities:**

The development of cage culture, particularly for small-scale producers, figures widely in sectoral planning recommendations in most parts of the region and elsewhere (Beveridge, *op cit*) The project will therefore have direct relevance to the demands of target countries and addresses key areas of the Aquaculture research Programme Purpose 2 outputs, viz 2.3 (fertilisation/nutrition/environmental quality and production in SIFS) 2.4 (social and bioeconomic constraints to pond/cage aquaculture identified, strategies promoted), and would contribute to 2.5 (strategic approaches to sustainable small-scale coastal aquaculture).

**Target Institutional Agreement:**

The following institutions have agreed to work with the objectives of the research:

15d. What will the project contribute to resolving these problems or needs and over what time-scale?

A better understanding of the context for small-scale cage culture development in targeted areas will improve partner institutions capacity to assist in the development of sustainable cage culture technology. The research process itself will aim to address these problems directly in case study locations, through partnership with local institutions and farmers in the establishment of the research agenda, activities, monitoring and evaluation. Through a project end workshop and project

15e. **What is the geographical focus of the project?**

Bangladesh and Vietnam

15f. **Which are the identified target institutions?**

- (I) CARE/DFID CAGES project. CARE - Bangladesh
- (II) University of Fisheries, Nha Trang, (Kanh Hoa) Vietnam

Market studies carried out for project outputs

There is a recognised demand for the output in terms of assisting the partner institutions, similar institutions in other regions of Asia, in the provision of targeted support to the development of small-scale cage culture systems.

How outputs will be made available to intended users:

Intended users include the partner institutions and similar institutions in other regions of Asia. Outputs will be made available directly to partner institutions and a number of associated institutions through collaborative research activities of the project. There will be a direct impact on the activities of partner institutions through the development of their support strategies for resource poor cage fish farmers (i.e. CARE DFID CAGES project, Bangladesh and extension and training activities of college of Agriculture and Forestry, University of Ho Chi Minh). There will be a direct impact on other relevant institutions through participation in the end of project workshops. Outputs in the form of peer reviewed papers and a planning manual "Planning and Development Guidelines for Small Scale Cage Fish Culture in the tropics" will be available to assist other development institutions in the tropics.

Further stages needed to develop outputs

The full development and evaluation of extension materials is beyond the scope of this project. The objective is therefore to include guidelines for this process in the above outputs. In addition, as a component of the partner institution development activities there will be a direct link with the extension materials development process for these institutions. Depending on the finding of the project, there may be opportunities to extend the development of such material to other areas, in collaboration with other development institution, such as the AIT OUTREACH project.

**15h. Who will the beneficiaries be and are there any groups who will be disadvantaged by the application of the research findings?**

The primary target group for the project are poorer groups within the case study communities, and might include landless groups and poor farmers, including both male and female beneficiaries. Other groups within the target communities may also benefit, but efforts will be made to ensure that this is not to the detriment of poorer less powerful sections of the community. The objective of the project is to develop systems, which will be compatible with other resource uses and the needs

**16. Is this proposal a continuation or extension of work already funded by DFID?**

Not directly. The project does extend the activities of the DFID funded partner institution in Bangladesh (CARE/DFID CAGES Project), bringing added value to both the research and development programmes of DFID

**SECTION C: SCIENTIFIC BACKGROUND**

**17. What work has previously been done or is currently being pursued towards the purpose, outputs and activities of the project? (A review of literature should be attached)**

Small-scale cage fish culture has emerged as an area of increasing opportunity for poor communities near inland and coastal waters (Beveridge 1996, Beveridge and Stewart, 1997). Typically simple low-cost structures of 1-5 m<sup>3</sup> are set singly or grouped together in sheltered river, lake or coastal waters and can produce 20-200 kg yr<sup>-1</sup> per unit based on natural productivity, variously enhanced with domestic wastes, agricultural by-products or by-catch. The potential for such technologies to address the needs of landless and other resource-poor groups has been recognised within a number of DFID activities, of which the Bangladesh CAGES project is a particular example (CARE 1996). Potential has also been identified in a recent study in Vietnam (Hambrey *pers comm*: trai 1997, Son 1996), and cage culture has been one of the measures proposed for balancing corporate development in shrimp culture in coastal areas, by providing alternative employment, and opportunities for small scale producers. Corporate shrimp culture is a misnomer in the case of both Thailand and Vietnam, where small-scale producers dominate the industry. Although shrimp is accessible to small-medium sized producers, competition for land and poor planning of water supply has resulted in production problems. While the merits of cage culture can easily be recognised, a number of underlying questions remain unresolved and could potentially constrain or jeopardise the very significant longer-term promise of these approaches. Key issues include

?? Social and institutional context: questions of water resource ownership, rights of access and use, and use conflict, status of operators; market opportunities (CARE 1996, Beveridge and Stewart, 1997)

?? Environment: identification of suitable environments; interactions between culture system and environment, potential impacts on other resource uses and users (Beveridge et al 1996. Beveridge and Stewart 1997);

?? Technical options and viability for resource poor producers; stock and nutrient



## SECTION D OUTPUTS AND ACTIVITIES

### 18a. what are the outputs of the project?

1. A review of small-scale cage culture to define the multidisciplinary context, define key parameters, performance indicators and identify target issues in both Bangladesh and Vietnam. This will be based on existing published information, including project documentation of partner institutions, interviews with secondary stakeholders in study regions (including project staff, government departments, and relevant NGOs).

#### Bangladesh

2. Case studies to examine the technological, economic, social and institutional aspects of current and potential small- scale cage culture developments.
3. Technology identification and testing: In collaboration with participating farmers and CAGES research staff, assess the potential viability of a range of technological options for low input cage aquaculture suitable for resource poor households in rural Bangladesh.
4. Participatory impact monitoring and evaluation methods development and testing.

#### **1.1.1 Vietnam**

5. An assessment of the costs and sustainability of seed supply to marine cage culture in Khanh Hoa Province.
6. Rapid appraisal of all relevant institutions. A comprehensive institutional analysis carried out.
7. Participatory rural appraisal with cage farmers and the communities in which they are based.
8. Review of costs and sustainability of current and potential feed sources for a range of species.

### 18b. What are the objective verifiable indicators for the outputs?

1. Background review of small scale cage culture in Asia
2. M.Sc. thesis completed and accepted.
3. 3. Case studies on small scale cage culture completed, presented in the form of a report which may be developed as a peer review publication, and guidelines for small scale aquaculture development, disseminated to identified stakeholders.

### 18c. What are the means of verification of the outputs?

Workshop reports  
M.Sc thesis accepted.  
Reports produced.  
Publications distributed to relevant stakeholders.



**18d. What are the expected environmental impacts? (beneficial, harmful, neutral)**

**i) Direct**

The environmental impacts of cage culture on a water resource depends on the type of cage culture technology used, the specific nature of the environment concerned, and the criteria for valuing that impact. The low input technologies, which represent the focus of this project, are more likely to represent a positive environmental impact in most situations. Where these systems are relying partially on the natural productivity of the water body for production, their presence will represent a net nutrient removal from the system, increasing the water quality which may be regarded as a benefit, or reducing productivity, which may represent a cost to other users (i.e. fish production). Where net additions of nutrients occur, the impact could be considered as negative (where deterioration in water quality impacts other resource users) or positive, in terms of increasing yields of fish culture or fisheries activities. It is an objective of the research to identify the approach to the determination of criteria for such impacts in specific development locations.

Low input cage aquaculture often relies on seed taken from the wild (although the feasibility of hatchery seed production will be investigated during this project). This removal of fish stocks from the wild will reduce the number of potential recruits in to wild fish stocks, which may lead to a reduced catch for potential fishermen. The over collection of under sized fry is already a problem in

**ii) Indirect**

As above

**19a Describe the projects activities**

1. A review of small-scale cage culture to define the multidisciplinary context, define key parameters, performance indicators and identify target issues in both Bangladesh and Vietnam. This will be based on existing published information, including project documentation of partner institutions, interviews with secondary stakeholders in study regions (including project staff, government departments, and relevant NGOs).

**Bangladesh**

2. Research planning workshop to finalise research framework and schedule, preliminary identification and assessment of key issues, and to allocate responsibilities.

3. Develop case studies. Examine in terms of technological, economic social and institutional aspects of current and potential small-scale cage culture developments. These will be designed to identify the range of issues and different stakeholder's perceptions of these issues in relation to the wider development context. They will also seek to identify the generalised features of these systems and their development opportunities and needs, from which project outputs (in terms of guidelines for small-scale cage aquaculture development can be developed.

4. Based on the identification of key researchable constraints (e.g. problems of

Impact monitoring appropriate to Bangladesh.

Vietnam

6. Research planning workshop to finalise research framework and schedule, preliminary identification and assessment of key issues and to allocate responsibilities.
7. An assessment of the costs and sustainability of seed supply to marine cage culture in Khanh Hoa Province. This work to be undertaken as part of a M.Sc. thesis, completion 1998. Will build on a previous study on the technical and economic potential of grouper culture in this area.
8. Rapid appraisal of all relevant institutions. A comprehensive institutional analysis would be carried out as part of a M.Sc. thesis in 1998/99, completion 1999.
9. Participatory rural appraisal with cage farmers and the communities in which they are based. PRA with potential cage farmers identifying major issues, potentials and constraints.
10. Review of costs and sustainability of current and potential feed sources for a range of species. This work to be undertaken as part of a M.Sc. thesis, completion April 2000.
11. Comparative economics, resource profiles, and overall sustainability of alternative species for cage mariculture. This will include comparison with brackish pond culture of grouper, shrimp and crab.

**19a Describe the project activities (Continued)**

**19b. What factors could prevent the attainment of:**

**i) Planned activities**

A lack of finance for key staff costs and overseas travel and subsistence limits the amount of time personnel from IoA and AIT are able to spend guiding the project and fully analysing data obtained from project activities.

Additional finance may be required for end of project workshop to allow all participants to take part in evaluation and dissemination of results from the project.



**ii) Outputs**

If sufficient finance is not obtained the quality of key outputs may be lower than desired.

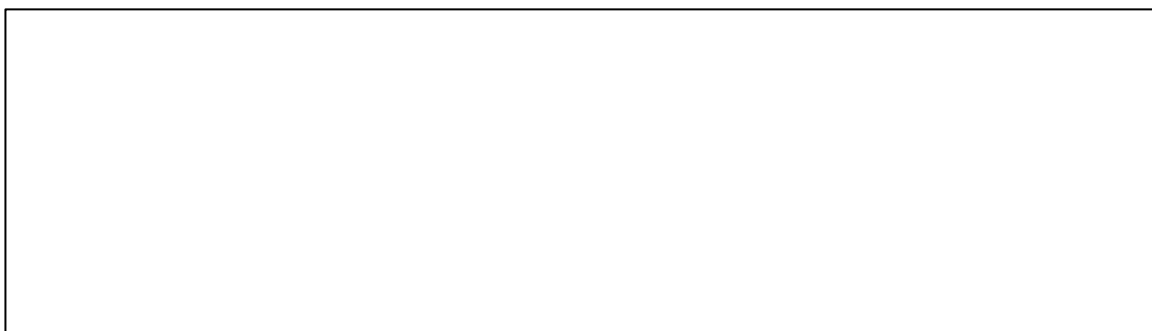
**iii) Project Purpose**

Off farm factors become unfavourable for the continuation/development of small-scale cage culture systems by potential beneficiaries

**i) Project Goal**

Change in the environmental, social or institutional environment may have impact on the ability of the project outputs to achieve the identified goal. The most critical factor is the ability of partner institutions and other identified institutions, to maintain the institutional capacity to implement project outputs into their development activities.

**20. Complete a bar chart or attach milestone charts over the life of the project.**



**SECTION E: FINANCIAL INFORMATION**

**21a. Total funding requested from DFID**

£114 315

**21b Summary of funding (£) requested from DFID to be shown by DFID financial years 1 April to 31 March (also complete Section 22)**

YEAR	1997/98	1998/99	1999/00	TOTALS
Staff Costs	11375		23237.5	22025
566367.5				
Overheads	3510		6075	59267.5
15512.5				
Equipment	3840		0	0
3840				
Overseas Travel	4275		7525	8525
20325				
Miscellaneous	2000		6500	9500
18000				
VAT				
Target Costs	25000	43480	35380	
TOTAL COSTS	25000	43337.5		45977.5
114315				

**21c. Will your organisation charge DFID Value Added Tax? Yes/No**

**VAT registration number**

**21d. Contributions from other organisations towards the costs of the project**

In kind contribution in the form infrastructure from collaborating institutions, including office facilities, transport, equipment, and workshop running costs.

**21e. If this proposal is being submitted elsewhere for funding state the organisation and when a decision is expected**

NA



**22a. Staff Costs**

SALARY COSTS: (Salary, National Insurance, and Superannuation contributions should be shown separately for each person). All likely salary increases and inflation must be allowed for> If staff are on incremental scales, give incremental date for each staff category.

Name and Percentage of Time Charged For	GRADE	PERIOD 1997/98	PERIOD 1998/99	PERIOD 1999/00	TOTAL
<b>UK/AIT STAFF COST</b>					
M C M Beveridge (@3600/month)		0	1800	1800	3600
J A Stewart Year 1 @ 2300/month Year 2 @ 2358/month Year 3 @ 2416/month		1500 (0.65mo)	3000 (1.27 mo)	3000 (1.24mo)	7500
K I McAndrew Year 1 @ 1782/month Year 2 @ 1828/month Year 3 @ 1873/month		5000 (2.8 mo)	6250 (3.4 mo)	6250 (3.3 mo)	17500
J Hambrey (@ 300/day) Year 1: 10 days Year 2: 15 days Year 3 : 12 days		3000	4500	3600	11100
		0	3000	3000	6000
<b>LOCAL STAFF COSTS</b>					
<u>Bangladesh</u>		937.5	625		2500
Social Scientist (pa)					
<u>Vietnam (£ =1.6\$)</u> Senior Local Staff (@ 31.25/ day)				937.5	

30 days 20 days 30 days			2500		5000
Project Officer (@ 12.5/day) 200 days			625	2500	625
PRA Assistants (@ 6.25/ day) 2*50 days@		937.5	937.5	937.5	2812.5
M.Sc Student (Supplement Grant of \$1500 / year )					
SUB-TOTALS		6500 4875	11050 9187.5	11050 7975	28600 22037
VAT					
TOTALS		11375	23237.5	22025	56637.5

## 22b. Overheads

This section must include any overheads stating method of calculation

Details	GRADE	PERIOD 1997/98	PERIOD 1998/99	PERIOD 1999/00	TOTALS
<u>Asian Institute of Technology</u> (12% of staff Costs)		(4875) 585	(9187.5) 1102.5	(7957) 955	(22019.5) 2642.5
<u>Institute of Aquaculture</u> (45% of Staff Costs)		(6500) 2925	(11050) 4972.5	(11050) 4972.5	(28600) 12870
SUB- TOTALS		3510	6075	5927.5	15512.5
VAT					
TOTALS		3510	6075	5927.5	15512.5

**SECTION E: FINANCIAL INFORMATION** (Continued)

22c. Capital Equipment

Is it assumed that the laboratory where the work is to be done is adequately equipped with the basic tools to undertake the work. In the event of additional equipment being required, it must be project-specific and full justification must be given for its purchase. Equipment purchased from DFID funds should be of UK manufacture. If non-UK goods are required, NRRD must be considered.

All non-expendable items which cost £500 or more to purchase (excluding VAT) remain the property of the Department for International Development and must not be disposed of without the prior permission of NRRD. No items must exceed £ 25 000.

Detailed specifications should be given for all items including details of suppliers and catalogue numbers where known and the financial year in which they will be required.

DETAILS	GRADE	PERIOD 1997/98	PERIOD 1998/99	PERIOD 1999/00	TOTALS
Computers Printers Software (*2)		3640			3640
Water Quality Test Kits		200			200
SUB- TOTALS		3840	0		
VAT					
TOTALS		3840	0		

**SECTION E: FINANCIAL INFORMATION** (Continued)

**22d. Overseas Travel and Subsistence**

Please itemise airfares (economy class), subsistence, etc.

DETAILS	GRADE	PERIOD 1997/98	PERIOD 1998/99	PERIOD 1999/00	TOTAL
UK- Bangladesh 2/yr @ 1000		2000	2000	2000	6000
Bangladesh- Thailand 2/yr @ 250		250	500	500	1250
Thailand- Vietnam 3/yr @ 500		0	1500	1500	3000
UK-Vietnam @ 1000		0	0	1000	1000
Subsistence 60 days per year @ £40/day		1400	2400	2400	6200
LOCAL STAFF <u>Bangladesh</u> (Costs covered by CAGES project)		0	0	0	0
<u>Vietnam</u> Staff WORKSHOP (2*\$500 = £)		625	500	500	1000
			625	625	1875
SUB- TOTALS		4275	7525	8525	20325
VAT					
TOTALS		4275	7525	8525	20325

**SECTION E: FINANCIAL INFORMATION** (Continued)

**22e. Miscellaneous**

This section should include UK travel and all other costs not covered by 22a-22d.

DETAILS	GRADE	PERIOD 1997/98	PERIOD 1998/99	PERIOD 1999/00	TOTALS
<b>Publications</b>					
<b><u>Bangladesh</u></b>		0	1000	1000	2000
<b><u>Vietnam</u></b>		0	1000	1000	2000
<b>Consumables</b>		500	500	500	1500
<b><u>Bangladesh</u></b>		500	1000	1000	2500
<b><u>Vietnam</u></b>					
<b>Contingency</b>		500	1500	1500	3500
<b><u>Bangladesh</u></b>		500	1500	1500	3500
<b><u>Vietnam</u></b>					
<b><u>End of Project Workshop</u></b>		0	0	3000	3000
<b>SUB-TOTALS</b>		2000	6500	9500	18000
<b>VAT</b>					
<b>TOTALS</b>		2000	6500	9500	18000



### ***III. Project Staff***

<b>Project Leader</b>	<i>Malcolm Beveridge</i> , The Institute of Aquaculture, University of Stirling. Stirling, U.K. FK9 4LA.
<b>Research Scientist</b>          <b>Research Assistant</b>	<p><i>John Hambrey</i>, The Asian Institute of Technology, Thailand c/o Crancil Brae House, Stathpeffer, Ross-shire IV14 9AW</p> <p><i>Paul Bulcock</i>, The Institute of Aquaculture, University of Stirling. Stirling, U.K. FK9 4LA.</p> <p><i>Ken McAndrew</i>, The Institute of Aquaculture, University of Stirling. Stirling, U.K. FK9 4LA.</p> <p>The CARE CAGES Project, CARE-BANGLADESH, 65 Road 7/A, Dhanmondi, Dhaka-1209, Bangladesh.</p>
<b>Field Assistants</b>	<p><i>Le Anh Tuan</i>, The University of Fisheries, Nha Trang, Vietnam</p> <p><i>Ta Khak Thoung</i>, The University of Fisheries, Nha Trang, Vietnam</p>
<b>Social Scientist</b>	<i>Cecille Brugere</i> , Department of Agricultural Economics and food Marketing, University of Newcastle, Newcastle upon Tyne. NE1 7RU.

<b>Database Analysis</b>	<i>Stuart Bunting</i> , The Institute of Aquaculture, University of Stirling, Stirling, U.K. FK9 4LA.
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## ***IV. List of Outputs***

## Improved management of small-scale tropical cage culture systems in Asia

### **2 DFID Renewable Natural Resources Research Programme 1997-2000**

#### **3**

#### **4 Outputs**

##### **1. Peer reviewed publications (including peer reviewed conference proceedings)**

###### **Published**

- ?? Huchette, S., Beveridge, M.C. M, Baird, D.J & Ireland, M. 2000. *The impacts of grazing by tilapias (Oreochromis niloticus L.) on periphyton communities growing on artificial substrate in cages.* Aquaculture 186 pp 45 -60.
- ?? Beveridge, M. C. M & Muir, J. F. 1999. *Environmental impacts and sustainability of cage culture in Southeast Asian lakes and reservoirs.* In: W L T van Densen and M J Morris (eds) *Fish and Fisheries of Lakes and Reservoirs in Southeast Asia and Africa.* Westbury Publishing, Otley, U.K. pp. 383-396.

###### **4.1.1.1 In press**

- ?? Beveridge, M C M 2000. *Overview of cage aquaculture.* In: P T K Woo, D W Bruno & S L H Lim (eds.) *Diseases in Finfish in Cage Culture.* CAB International, Wallingford, Oxon.
- ?? Chen, Y. S, Beveridge, M. C. M. & Telfer, T. C. 2000. *Derived data for more effective modelling of solid wastes dispersion from sea cage farms.* Asian Fish. Sci.
- ?? Hambrey, J.B. 2000. *Global prospects for cage aquaculture of marine finfish: input costs, market value, and comparative advantage.* Proceedings of the First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Science
- ?? Hambrey J.B, Tuan L.A. *Status of cage mariculture in Vietnam* Proceedings of the First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Science
- ?? Kabir K. M. and Huque Z 2000. *Cage Design in the CARE –CAGES Project, Bangladesh. CARE – CAGES Project, Dhaka, Bangladesh.* Proceedings of the First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Science.
- ?? McAndrew K.I. 2000. *Risks to Small-Scale Cage Farmers in Bangladesh, with Emphasis on Fish Health. Experiences of the CARE – CAGES Project.*

Proceedings of the FAO/ NACA/ DFID regional workshop on Primary Aquatic Animal Health care in Rural Aquaculture Development workshop, Dhaka, Bangladesh.

?? McAndrew, K , Brugere, C, Beveridge, M. C. M, Ireland, M. J, Tapash, R & Yesmin K. 2000.

*Improved management of small-scale tropical cage culture systems in Bangladesh: potential benefits of an alliance between an NGO and a western research institute.* In: P. Edwards, D C

Little & H Demaine (eds.) *Rural Aquaculture*. AIT, Bangkok.

?? McAndrew, K.I., D. Little & Beveridge, M.C.M. 2000. *Entry points and low risk strategies appropriate for the resource poor to participate in cage aquaculture. Experiences from the CARE – CAGES project, Bangladesh.* Proceedings of the First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Science.

**In review**

?? Brugere C, McAndrew K.I Bulcock P. *Gender issues in small-scale cage culture, Bangladesh.* Journal of Aquaculture Economics and Management.

?? Bulcock P, Sommerville C, McAndrew K.I & Dutta S. 2000,. *Alitropus typus (Milne-Edwards 1840). An infestation of caged fish in Bangladesh.* Journal of Fish Diseases

?? Ireland M.J, Bulcock P, McAndrew K.I, Ahmed N.A, Huque Z & Beveridge M.C.M 2000. *Poverty reduction and small-scale cage aquaculture in Asia - A review of development in Bangladesh.* Journal of Asian Fisheries Science

?? Zakir, Bulcock P 2000, *Is Poor Growth Expressed By The Common Carp (Cyprinus carpio) under CARE CAGES culture a result of feeding practises, A Case Study.* Journal of Tropical Aquaculture.

**4.1.1.1.2**

**4.1.1.1.3 In prep**

?? Hambrey, J.B. and L. A. Tuan.. *Comparative economics and sustainability of different coastal aquaculture options (Journal of Aquaculture Economics and Management – target)*

?? Williams, K., Tuan, L. A., and J. B. Hambrey. *Alternative feed formulations and feeding strategies for marine cage culture in Vietnam (Journal of Fish Nutrition, Naga, Target)*

**2. Non peer reviewed materials (including conference proceedings, conference articles and extension leaflets)**

**4.1.1.1.3.1 Published**

- ?? Brugere C, Mc Andrew, K.I, Bulcock P. 2000. *Impact of small-scale aquaculture at the community level*. Aquaculture Asia. July-Sept. pp. 29-32.
- ?? Bulcock P & Brugere C. 2000. *Identifying research needs in adoption of cage aquaculture, Bangladesh*. Aquaculture News, No 26. an IoA Publication.
- ?? Hambrey, J.B., Nho, N.T., Tuan, L.A., Hoa, D.T., Thuong, T.K. 1999. *Poverty Alleviation and Marine Cage Culture in Vietnam (social, economic and institutional issues)*. AARM Newsletter, Bangkok, Thailand. Vol 4 No. 2 April 1999.
- ?? Hambrey, J.B., Nho, N.T., Tuan, L.A., Hoa, D.T., Thuong, T.K. 1999. *Poverty Alleviation and Marine Cage Culture in Vietnam (seed and feed supply)*. Aquaculture News. Institute of Aquaculture. Aquaculture News No. 25 pp 15-18. Institute of Aquaculture, University of Stirling.
- ?? IoA, NFEP & CAGES, *Low cost hapa system for quality tilapia seed production*. 10 000 extension leaflets written and printed in bangla. This pamphlet has since been distributed to potential beneficiaries through collaborative NGOs.
- ?? McAndrew K.I & Bulcock P. 1999 “*Research Support to the CARE CAGES Project in Bangladesh*” published in Aquaculture News No. 25, July 1999, an IoA Publication.

**4.1.1.1.3.2 In press**

- ?? Bulcock P & McAndrew K.I. 2000. *Guidelines for the production and extension of small-scale cage aquaculture in Asia*. Aquaculture News, an IoA publication.
- ?? Tuan, L A, and Hambrey, J.B. 1999 “*Sustainability of grouper seed supply to the aquaculture industry in Khanh Hoa, Vietnam*”. Aquaculture Asia.

**4.1.1.1.3.3 In prep**

- ?? Hambrey J.B Tuan L.A 2000. A working paper (in Vietnamese) of *Lobster seed supply in Khanh Hoa* has been completed.

**3. Other Publications**

**4.1.1.1.4 Published**

- ?? Brugere, C. and K. Yesmin, 1999. *Social surveys on the CAGES (Cage Aquaculture for Greater Economic Security) project*. DFID research project R7100, Institute of Aquaculture, University of Stirling, UK produced and disseminated.
- ?? Bulcock P 1999. *M.Sc Thesis, Investigations into an isopod affecting CARE CAGES culture Bangladesh* awarded external examiners prize for thesis at the University of Stirling. 78 pp.

- ?? *Bulcock. P. 2000. The DFID Funded Project R7100 'The Improved management of tropical small-scale cage culture in Asia* presented at the International Conference on aquaculture in the third millennium 20-25 February 2000 Central Grand Plaza Bangkok, Thailand.
- ?? *Bunting S. 1999. Improvements to the CARE - CAGES database.* Recommendations on the improved management of the database were made, instrumental in the restructuring of the CAGES database.
- ?? ***On-farm technical trial catalogue 1998/1999. CARE CAGES project Bangladesh 68 pp. The collation of the 28 technical trials implemented by R7100 in Bangladesh throughout the five regions where CAGES operates. Distributed to regional headquarters and collaborative NGOs as reference source.***
- ?? *Research farm trial catalogue 1998/1999 CARE CAGES project Bangladesh 117pp.* The collation of 22 trials conducted at the CAGES research farm in Dhaka region Bangladesh 1998/1999/2000. Trials were referenced catalogued and results and findings disseminated to all CAGES regions as reference source.
- ?? *Tuan L.A. 1998. M.Sc Thesis, The sustainability of seed supply to the aquaculture industry in Khanh Hoa Province, Vietnam.* 112 pp.
- ?? *Williams K, 2000. Aquaculture feeds consultancy for cage mariculture in Khanh Hoa Province, Vietnam'.*

## **5 Guidelines for planning and extension of small scale cage aquaculture**

- ?? Regional guidelines for development specialists and policy makers will be developed as a joint output of the Bangladesh and Vietnam components at the end of project workshop. These include the following:
- ?? *Checklist for the assessment of cage aquaculture potential;*
- ?? *Development profiles: standardised summaries of technology, site requirements, production parameters, resource use and risk profiles of selected alternative cage aquaculture options (these will be examples which may serve as the starting point for the development of a comprehensive regional handbook)*
- ?? *Development and communication techniques – a brief introduction/overview and assessment of strengths and weaknesses;*
- ?? *Policy initiatives for cage culture development - a brief introduction/overview and assessment of strengths and weaknesses;*

### **Final R7100 report**

*Bulcock P. Beveridge M.C.M & Hambrey J. 2000. Final R7100 Technical report The Improved Management of tropical small-scale cage aquaculture in Asia.*

## **4. Non-publications**

### **Oral presentations at conferences**



- ?? Kabir K. M. and Huque Z. 2000. *Cage Design in the CARE –CAGES Project, Bangladesh. CARE – CAGES Project, Dhaka, Bangladesh.* First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Society – World Aquaculture Society
- ?? McAndrew, K.I, Little D. & Beveridge. M.C.M. 2000 *Entry points and low risk strategies appropriate for the resource poor to participate in cage aquaculture. Experiences from the CARE-CAGES project Bangladesh.* First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Society – World Aquaculture Society
- ?? McAndrew K.I *Fish health risks to small-scale cage farmers in Bangladesh.* In an FAO/NACA/DFID regional workshop on Primary aquatic health care in rural aquaculture development, in Dhaka from the 27<sup>th</sup> to the 30<sup>th</sup> September 1999. 77
- ?? Hambrey J.B *Global trends in terms of input cost and supply, and market value of marine fin-fish* was presented to the 1<sup>st</sup> International Symposium on Cage Culture in Aquaculture in Taiwan 2<sup>nd</sup>-6<sup>th</sup> November 1999. Asian Fisheries Society – World Aquaculture Society
- ?? Hambrey J.B Tuan L.A. *Status of cage mariculture in Vietnam.* Proceedings of the First International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. Asian Fisheries Society – World Aquaculture Society.

#### 5.1.1.1.1 Short courses and workshops

- ?? Within Bangladesh included those conducted by Ms Cecille Brugere *Social-economic issues in Development and the use of Participatory Rural Appraisal methodology.*
- ?? A one day workshop concerning the *Hapa breeding of tilapia* was organised between CAGES, NFEP-“ (North west Fisheries and Extension Project) and R7100. The workshop consisted of all CAGES field staff and representative of 30 partner NGOs. Outputs of this workshop were summarised and made available to all interested parties.

##### 5.1.1.1.1.1 Training

- ?? **In order for on-farm trials to occur within the Bangladesh component of R7100 the training of CAGES (TO)s and NGO staff in the areas of trial design, methodology and interpretation was conducted via workshops and seminars by R7100**
- ?? **Additionally through further training of CAGES and other CARE staff occurred on the use of statistical methods and the use of MS Excel.**
- ?? **The training of CAGES staff is not stated in the logframe, however, it was felt that the computing skills of staff, with the exception of MS WORD, were poor and that training would greatly benefit both staff development and project outputs.**

##### 5.1.1.1.1.2

## V. Interim reports

**RNRRS Programme: R7100**

**Short Title:** *Improved management of small-scale tropical cage culture systems in Asia*

**Project Leader:** *Dr M.C.M. Beveridge*

**Start Date:** *1<sup>st</sup> February 1998*

**End Date:** *31<sup>st</sup> October 2000*

**DFID Quarterly Report (1)**

**June 1998**

The main objectives during this time were for Mr McAndrew to introduce himself to CARE - CAGES staff, understand the structure of the CAGES project, and through close contact with CAGES staff, NGO's and fish farmers, identify specific areas where CAGES 2 can be most beneficial to rural poor cage farmers in Bangladesh. Work will focus in 3 regions of Bangladesh Jessore, Dhaka, and Comilla.

**Activities**

**Information Obtained**

Constraints and opportunities of cage aquaculture were discussed at regional workshops by NGOs and CAGES staff. These workshops were an important source of information allowing the views of many cage farmers to be obtained in a short time. Mr McAndrew also attended an Aquaculture Workshop on 3<sup>rd</sup> - 4<sup>th</sup> May 1998, at which employees from CARE - CAGES, NOPEST and INTERFISH presented papers on their current projects.

A database containing information on all cages farmed during the 1997 production cycle was obtained from CARE-CAGES. The data include detailed financial returns.

Bangladesh grey literature at the Fisheries Management Support Office, as well as CARE -Bangladesh library was read to further increase knowledge of what has previously been done in Bangladesh.

**Research Planned**

**CAGES farm Experiments**

This site was visited on several occasions. Details of all previous Trials were obtained and discussed with farm manager and other CAGES staff. Discussions included Trial designs and statistics used. Advice was given on more rigorous experimental design and methodologies in order to improve results. This included more use of replicates and individual measurement of fish, which will allow the variance in the population to be known. Future research priorities were discussed and will be developed in the next few months with inputs from staff at the IoA, Stirling, and CAGES staff via E-mail.

## NGO's and Farmers Experiments

### a) GIFT case studies

Case studies were set-up to compare the production of GIFT with local tilapia strains. Questionnaires were written with the help of CAGES staff to establish the farmers social status, previous aquaculture experience, husbandry techniques, marketing, potential constraints and expectations for this season.

Local CAGES staff in the Dhaka and Comilla areas will carry out the case studies. This questionnaire will be followed up with another at the end of the production cycle where a detailed analysis of the difference between GIFT and local strains will be carried out.

Three farmers in the Dhaka area have already agreed to take part in the case study. Each of these will have 2 cages, 1 with GIFT and the other stocked with local strain. A total of 6 farmers in the Comilla area have also agreed to take part. These farmers have 1 cage each and 3 will stock GIFT while the other 3 will stock local Tilapia strain.

In all cases fish will be batch weighed at the beginning and end of the culture period, in addition 30 randomly selected fish will be measured to indicate variance within the population.

### b) Leaf feed

A common tree, local name Ghora Neam was used by one farmer last year to feed Silver Barb, with good results. It is now being recommended to all farmers by a particular NGO. We will investigate using case studies in exactly the same way as for GIFT tilapia. Two farmers which will feed the leaf and 2 that will not have already been selected in the Comilla area.

### c) Investigation of isopod-related problems

In Jessore a parasite is causing major problems, making cage aquaculture difficult in large areas of river. A sample of the parasites were placed in formalin and taken back to Stirling where they are currently being investigated by parasitologists. The parasitology group is very interested in further study of this parasite, and future work is at present being discussed. All information obtained has been E-mailed back to CAGES staff who will pass it on to effected farmers.

### d) Other NGO work

During visits it became clear that NGOs are performing a wide range of Experiments. There is however much repetition of the same work, varying quality of experimentation, and no permanent record of these trials and their results. It was proposed that in the next visit NGO experiments are written up and compiled. This booklet would then be given out to NGOs at regional meetings before the start of next season. CAGES farm trials will also be included. This would allow all NGOs to build on the research already carried out, improve experimentation knowledge via discussion of experimental design and this output would provide a permanent record of the many NGO experiments.

## 6 Future Visits

Next visit is planned for October or November 1998. The main activities will be :

- ?? writing a literature review on cage aquaculture in Bangladesh and Vietnam.
- ?? compiling NGO experiments
- ?? making a poster from data on this project to be presented at the Asian Fisheries Conference, Thailand in November 1998.
- ?? discussing results and helping with analysis of Experiments from this year
- ?? researching constraints and opportunities of cage aquaculture in Bangladesh and then designing with CAGES staff appropriate experiments, the results of which would benefit the rural poor farmer in Bangladesh.

**DFID Quarterly Report (2)**

**Sept 1998**

**The CAGES 2 Project is proceeding according to schedule, with no unforeseen difficulties. Mr McAndrew left for Bangladesh at the beginning of November.**

All partners, including Dr Beveridge and Dr Hambrey and Vietnamese staff from Nha Trang, met at the 5<sup>th</sup> Asian Fisheries Society Meeting in Chang Mai to discuss progress and next year's trials. A poster presentation on the project was also given and as a result have been requested to produce a chapter for a book on rural aquaculture in Asia, to be published by AIT next year.

Mr McAndrew returned to Bangladesh on 15 November and was joined a few days later by Ms Cecile Brugere who has gone out to assist CARE with surveys of participants in the CAGES project. Both return to UK in mid-December.

**6.1 Highlights of Achievements**

An abstract on the project has been accepted for a poster presentation at the 5<sup>th</sup> Asian Fisheries Forum, to be held in November 1998 in Chaing Mai, Thailand.

**6.2 Progress Towards Outputs**

Output 1. The current status and characteristics of the small scale cage aquaculture sector in Asia assessed.

Communications have taken place between Ken McAndrew, Stirling and John Hambrey, AIT as to the content and timing of this review. Prof Nho, from University of Fisheries, Nha Trang, Vietnam has been preparing a review of small-scale cage culture in Vietnam, and Mr McAndrew has been doing likewise for Bangladesh. Further discussions will take place at the Asian Fisheries Conference in November, with the review completed by March 1999.

Output 2. Technological, economic, social and institutional context for small-scale cage aquaculture development assessed for two regional locations (Bangladesh and Vietnam).

**7 Bangladesh**

?? Technical trials set up on Mr McAndrew's previous visit to Bangladesh are still under way, and will be evaluated in November 1998 when he returns to Bangladesh.

?? The social issues of most importance to cage aquaculture in Bangladesh have been identified by CARE-Bangladesh and action plans are currently being discussed between CARE-Bangladesh and Stirling.

?? The institutional context of small-scale cage aquaculture in Bangladesh will be investigated as part of the planned literature review.

**8 Vietnam**

?? The series of activities detailed in project logframe for Vietnam are currently being set-up and carried out to produce Output 2.

Output 3. Guidelines for planning and extension of small scale cage aquaculture produced.

This output is not intended to be produced until the end of project workshop in March 2000.

**8.1 Achievements Against Logframe**

Work is progressing satisfactorily.

**8.2 Activities during Quarter**

- ?? Stirling are preparing recommended practices for small-scale cage aquaculture species presently farmed in Bangladesh. This review is based on published literature, and will be completed in conjunction with CAGES staff and incorporating their knowledge and experience. The guide will then be made available to all Technical Officers on the CAGES project to allow good technical advice to be offered to NGO's and participating farmers.
- ?? Stirling has been in communication with several members of CAGES staff giving advice on possible future technical Trials as well as experimental design and statistical methodologies of current Trials.
- ?? Communications between Stirling and CAGES staff have resulted in the employment of Ms Cecile Brugere, Institute of Aquaculture Stirling to be responsible for establishing and managing investigations of social issues deemed essential (by CAGES and IoA staff) for the successful uptake of cage aquaculture for resource poor farmers in Bangladesh. Ms Brugere is currently planning these activities with Mr McAndrew.
- ?? Work in Vietnam is progressing satisfactorily.

### 8.3 *Dissemination Outputs During Current Quarter*

The Asian Fisheries abstract was the only formal project output this quarter although the numerous e-mail communications to CAGES staff are also informal outputs, which have immediate uptake.

### 9 *Planned Activities for next Quarter*

Planned visits of Stirling staff

Mr McAndrew will visit Bangladesh from 1<sup>st</sup> November to 10<sup>th</sup> November. Here he will assess progress on Trials set up on previous visit. Consult with all CAGES staff on future activities and have completed action plans for himself and Ms Brugere for their visits to Bangladesh. CAGES staff will also be consulted about the poster to be presented at the Asian Fisheries Forum in Thailand.

Mr McAndrew will then go to Thailand and present a poster at the Asian Fisheries Forum. While in Chaing Mai he will consult with Dr John Hambrey and others on the project on the work being done in Vietnam. This will include detailed discussions on the literature review.

Mr McAndrew will return to Bangladesh on 17<sup>th</sup> November, returning to UK on 13<sup>th</sup> December 1998. During this time future technical Trials will be assessed and set-up Ms Brugere will arrive on 18<sup>th</sup> November, returning to UK on 16<sup>th</sup> December. During this time she will be responsible for running a workshop on social issues in ANR projects. Mr McAndrew and key CAGES staff will also be involved in this activity. Ms Brugere will also, in close collaboration with key CAGES staff, set up:

- ?? An assessment of household decision making in the management of small-scale aquaculture with particular emphasis on the role of woman.
- ?? An assessment of the ability of resource poor farmers to remain in cage aquaculture
- ?? An assessment on the effect of environmental impacts caused by cage aquaculture on communities.

John Hambrey from AIT will visit field sites and personnel in Vietnam in mid-October to assess progress, report writing and brainstorming. Outputs from this session will comprise an interim progress report and an on-going research plan. A summary of these outputs will be presented in the poster presentation at the 5<sup>th</sup> Asian Fisheries Forum.

**Planned Modifications to Project Implementation (e.g. outputs, logframe etc.)**

The employment of Ms Brugere is a deviation from the logframe where a local social scientist was to be employed. **However a suitable person could not be found.**

**10 Dissemination Outputs Expected Next Quarter**

Poster presentation at the 5<sup>th</sup> Asian Fisheries Forum.

Publication of recommended technical practices for resource poor cage farmers in Bangladesh for a range of species.

Interim progress report on the work in Vietnam.



## **11 DFID Quarterly Report (4) March 1999**

### **11.1 Highlights of Achievements**

Poster presentation on CAGES project at the 5<sup>th</sup> Asian Fisheries Forum, Chang Mai, Thailand, 10–15 November, 1998 (Ken McAndrew).

### **11.2 Progress Towards Outputs**

*Output 1.* The current status and characteristics of the small scale cage aquaculture sector in Asia assessed.

Ken McAndrew during his last trip to Bangladesh, read and compiled grey literature, and conducted interviews with all CAGES Technical Officers (TO)/ assistant Project Officers (APO), as well as government, DFID, BAU and NGO staff in Bangladesh who have past experience in cage aquaculture. This information is presently being compiled for the Bangladesh literature review. Further inputs were provided by Mark Ireland (CARE-CAGES co-ordinator) who visited Stirling 17-18 December. The Vietnam section of the literature review is being assessed by workers in Vietnam, and compiled by John Hambrey and his RA Tuan. Both sections will be amalgamated at the project workshop in Vietnam (23 - 26 April 1999). A paper will then be submitted for publication in a peer review journal.

*Output 2.* The technological, economic, social and institutional context for small-scale cage aquaculture development is being assessed for two regional locations (Bangladesh and Vietnam).

## **12 Bangladesh**

- ?? On-farm technical trials, established during Mr McAndrew's previous visit to Bangladesh, are currently being compiled and incorporated into either the output on "farmer/NGO experiences/experiments" or the information used in the "manual of recommended practice" Some of this information will also be used in the literature review.
- ?? Technical Trials that were planned and carried out at the CAGES research farm are being written up for possible publication in peer reviewed scientific journals.
- ?? Ms Cecile Brugere, in collaboration with CAGES staff, established three surveys on, i) reasons for household cage operators to abandon or continue with cage aquaculture, ii) roles, costs, opportunity costs and benefits of cage aquaculture to households, with particular emphasis on the role of woman and iii) the impact of cage aquaculture at the community level. These were the social issues of greatest importance to cage aquaculture in Bangladesh (as identified by CARE – CAGES staff).
- ?? The institutional context of small-scale cage aquaculture in Bangladesh was investigated during interviews, and will be discussed as part of the literature review.

### 13 Vietnam

- ?? *Sector review of seed sources. A Masters thesis was completed successfully in August 1998 with the title "The sustainability of the seed supply to the aquaculture industry in Khanh Hoa Province, Vietnam"*
- ?? A comprehensive appraisal of feed supply issues is underway. This research is being undertaken mainly by Dr. Do Thi Hoa and Dr. Lai Van Hung of the University of Nha Trang, with additional advice from Dr Amaratne of AIT. The first phase of the study (nearing completion) is an assessment of the quantity, quality, prices and sustainability of existing feed supply to marine cage culture in Khanh Hoa
- ?? Assessment of comparative economics, resource profiles, and overall sustainability of alternative species for cage mariculture This will include comparison with brackish pond culture of grouper, shrimp and crab. This work is being undertaken mainly by the project officer (Mr Le Anh Tuan) with support from Dr Hambrey of AIT/NRDM
- ?? A preliminary institutional analysis was carried out as part of the Masters thesis on seed supply. Rapid appraisal of all relevant institutions; a comprehensive institutional analysis carried out; participatory rural appraisal with cage farmers and the communities in which they are based, is being undertaken and an output expected by end of project.
- ?? To date PRA has been undertaken mainly in respect of existing fish farmers, both cage and pond, with a view to identifying opportunities and constraints, especially for smaller scale and poorer households. This survey will be extended to other members of the local community not currently engaged in aquaculture, to assess the extent to which they might or might not benefit from entry to the industry, and identify the constraints to entry.

#### **Output 3. Guidelines for planning and extension of small scale cage aquaculture produced.**

This final output will not be produced until the end of project workshop in March 2000. However, an informal research workshop, including participants from Vietnam, AIT, the Bangladesh CAGES project and Stirling University will be convened in Vietnam in late April.

##### *13.1 Achievements Against Logframe*

Work is progressing satisfactorily. However it is anticipated that the literature review will not be submitted for publication until April 1999, one month later than anticipated in the logframe. The delay will allow project staff from Stirling and Vietnam to meet at the planned workshop in Vietnam in order to compile the Bangladesh and Vietnam sections of the review. This will result in a better quality output for publication.

##### *13.2 Activities during Quarter*

Ken McAndrew visited Bangladesh 2 November to 9 December (10-15 November at the Asian Fisheries Conference, Thailand).

Cecile Brugere, a social scientist from Stirling visited Bangladesh from 18 November until 16 December 1998. During this time three social surveys were established with CAGES project staff. In addition Ms Brugere held a workshop for all CAGES staff and interested individuals from other ANR projects on "Social-economic issues in Development" This was written up, and is available for CARE staff to use as reference and training material.

For Vietnam activities see above section.

### **13.3 Dissemination Outputs During Current Quarter**

A poster was presented at the Asian Fisheries Conference. Ms Brugere compiled her workshop on "Social-economic issues in Development this is available for CARE staff to use as reference and training material.

## **14 Planned Activities for next Quarter**

Planned visits of Stirling staff

- ?? Mr McAndrew will next visit Bangladesh from approximately 20<sup>th</sup> March 1998 until 22<sup>nd</sup> April 1999. During this trip the following activities are planned:
- ?? Workshop on hapa-breeding and nursery of GIFT tilapia. All cages staff, and interested NGO's in each region will be invited to attend.
- ?? A joint workshop will take place with Mr Parvez, the CARE- CAGES statistician and Mr McAndrew on experimental design, data storage, and basic statistical methodologies. All cages staff, and any other interested parties from CARE ANR sector will be invited to attend.
- ?? Mr McAndrew will spend 3 full working days in each of the 5 regions. During this time the literature review, book of recommendations, and farmer/NGO Trials will be completed. The time in each region will mainly be spent discussing details of these 3 outputs with CAGES staff and others, including DFID Bangladesh and NFEP (Northwest Fisheries Extension Project) staff.
- ?? While in regional visits a half-day workshop on fry conditioning and transportation will be organised by the TO/APO of each region, inviting GO, private hatchery/ nursery operators.
- ?? Investigate in more detail the problem of net durability, including net supply, quality and methods to increase longevity.

*Ms Brugere (subject to funding being made available) will next visit Bangladesh in April 1999 to work on the CAGES database with Mr Parvis. The intention is to determine what is important in successful cage aquaculture, and to look in detail at the information collected, recommending any changes in the information, which is collected each year by CAGES staff, and how this data is compiled and manipulated by CAGES staff to produce useful outputs. This data manipulation would be followed up by field visits to validate conclusions made. It is hoped that this work will bring out other key social issues, which can then be investigated further in November/December 1999.*

### **14.1.1.1.1**

Dr Malcolm Beveridge will visit Bangladesh in late April 1999. While here Malcolm will advise on project direction, discussing any issues with CAGES staff.

Mr Paul Bulcock, an MSc student at the Institute of Aquaculture will carry out fieldwork in Jessore region, Bangladesh on an isopod parasite. This project is being supervised by Dr Christina Sommerville (Parasitologist) and Mr McAndrew (in Bangladesh).

#### 14.1.1.1.2 Vietnam Workshop

During late April 1999 there will be a workshop held in Vietnam. This is an opportunity for some Bangladesh CAGES staff, and some NGO workers to experience first hand the marine cage culture systems operating in Vietnam. This workshop will be used to review progress of the CAGES 2 project, and plan future activities and outputs. It will allow researchers in both sections of the project to understand the work being carried out in both geographical regions, ensuring that both groups are aware of and are working towards the joint outputs to be prepared before project termination in March 2000. Activities will include:

- ?? presentation and discussion of research findings;
- ?? presentation and discussion of plans for further research and reporting;
- ?? clearer definition of the need for, and nature of guidelines.

14.1.1.1.2.1 A final workshop will be convened in Bangladesh early in the year 2,000 (subject to funding). This will once again bring together researchers and practitioners from Vietnam, Bangladesh, AIT and Stirling. Researchers will present and discuss main project findings, and identify research and development priorities for the future.

#### **Planned Modifications to Project Implementation (e.g. outputs, logframe etc.)**

The M.Sc. project in Bangladesh was not planned in the logframe, however using a student to investigate this isopod problem offers good value for money, a high level of intensive research and a guaranteed project output – in the M.Sc. thesis.

#### **15 Dissemination Outputs Expected Next Quarter**

Literature review of small-scale cage aquaculture in Bangladesh and Vietnam submitted to a peer reviewed publication. In addition country reviews may be published separately.

Publication of recommended technical practices for resource poor cage farmers in Bangladesh for a range of species. This output will be loose leafed so as the contents can be updated as better information becomes available.

Booklet of NGO/farmer experiences/Trials. This booklet will document the many Trials being conducted by cage farmers in Bangladesh.

Interim progress report on the work in Vietnam. Report on the first phase of a comprehensive appraisal of feed supply issues, detailing the quantity, quality, prices and sustainability of existing feed supply to marine cage culture in Khanh Hoa

#### **16 Other Comments**

Dr. John Hambrey wrote: The budget originally proposed for 1999/2000 should be adequate for most purposes, although we propose additional senior staff time (national and international) to ensure that the work is well written up and effectively disseminated in a variety of formats. The original budget is unrealistic in this regard, and without additional funds there is a real danger that the substantial research and collaboration effort which is now underway will be wasted.

## **17 DFID Quarterly Report (5) June 1999**

### **17.1 Highlights of Achievements**

- ?? Two-day workshop were carried out by Ken McAndrew and Mr Parvez (CAGES staff) to CAGES, and other CARE staff on 'Statistical methods and the use of MS Excel'.
- ?? A one-day workshop on 'Hapa breeding of tilapia' was organised. The workshop was attended by all CAGES field staff, approximately 30 NGOs, and researchers from the NFEP-2. Outputs of this workshop were summarised and made available to all interested parties.
- ?? Improved linkages were established between IoA, CARE and NFEP-2, including the production of joint outputs (in press) and a greater degree of information sharing. Staff visits and technology transfer was also facilitated.
- ?? Documenting and cataloguing of previous Trials at the Cages Research Farm.
- ?? Documenting and cataloguing of Trials carried out by NGOs and farmers.
- ?? Key opportunities and constraints were assessed through extensive field visits, and regional research plans drawn up with CAGES staff.
- ?? A successful M.Sc. project was carried out investigating an isopod parasite that had reportedly caused serious economic loss to cage farmers in Khulna district, Bangladesh.
- ?? The CAGES database assessed and improved, with training of key CAGES personnel.

### **17.2 Progress Towards Outputs**

**Output 1. The current status and characteristics of the small scale cage aquaculture sector in Asia assessed.**

Further progress has been achieved on the Bangladesh literature review, with a one-day meeting on 1<sup>st</sup> June, between Ken McAndrew and Mark Ireland (ex CARE-CAGES co-ordinator) resulting in the completion of a draft review document. It is felt that it would be more useful if separate Bangladesh and Vietnam literature reviews were produced, with key issues in each geographical area then being compared in a separate publication.

**Output 2. Technological, economic, social and institutional context for small scale cage aquaculture development assessed for two regional locations (Bangladesh and Vietnam).**

## **18 Bangladesh**

- ?? On-farm technical trials established during the previous visit of Mr McAndrew to Bangladesh were written up by NGO/ CAGES TO and APO, and edited by Ken McAndrew before any changes agreed upon by the field workers and the Trials catalogued. At present a computerised and hard copy of all documented Trials are being given to each regional office in the CAGES project to improve access to

information. Farmers/NGOs are being encouraged to write-up other Trials/Experiences in a similar way, so the catalogue of information is constantly being updated and is available to all cage operators.

- ?? Technical Trials that were planned and carried out at the CAGES research farm have been catalogued with a computerised and hard copy given to each regional office in the CAGES project to allow easy access to all information by cage operators. A number of Trials are currently being assessed as to their suitability for publication in peer reviewed scientific journals or in article form.
- ?? In December 1998, Ms Brugere, in close co-ordination with CAGES staff, established three surveys:
  - i. reasons for household cage operators drop out or continuation of cage aquaculture;
  - ii. roles, costs, opportunity costs and benefits of cage aquaculture to households, with particular emphasis on the role of woman, and
  - iii. the impact of cage aquaculture at the community level.

The data has now been analysed and sent to Bangladesh, with results being used to help interpret and progress key issues in the CARE – CAGES project. The key findings of surveys i and ii are currently being written up for publication. Survey iii will be repeated in November, with any changes in community assessment of cage aquaculture as a result of scaling-up of production being assessed. This will also be written up and published.

- ?? The institutional context of small-scale cage aquaculture in Bangladesh was investigated during interviews, and will be discussed as part of the literature review.

## 19 Vietnam

- ?? *Sector review of seed sources. A Masters thesis was completed successfully in August 1998 with the title "The sustainability of the seed supply to the aquaculture industry in Khanh Hoa Province, Vietnam"*
- ?? A comprehensive appraisal of feed supply issues is underway. The research is being undertaken mainly by Dr. Do Thi Hoa and Dr. Lai Van Hung of the University of Nha Trang, with additional advice from Dr Amaratne of AIT. The first phase of the study (nearing completion) is an assessment of the quantity, quality, prices and sustainability of existing feed supply to marine cage culture in Khanh Hoa
- ?? Assessment of comparative economics, resource profiles, and overall sustainability of alternative species for cage mariculture This will include comparison with brackish pond culture of grouper, shrimp and crab. This work is being undertaken mainly by the project officer (Mr Le Anh Tuan) with support from Dr Hambrey of AIT/NRDM
- ?? A preliminary institutional analysis was carried out as part of the Master's thesis on seed supply. Rapid appraisal of all relevant institutions; a comprehensive institutional analysis carried out; participatory rural appraisal with cage farmers and the communities in which they are based, is being undertaken and an output expected by end of project.

?? To date PRA has been undertaken mainly in respect of existing fish farmers, both cage and pond, with a view to identifying opportunities and constraints, especially for smaller scale and poorer households. This survey will be extended to other members of the local community not currently engaged in aquaculture, to assess the extent to which they might or might not benefit from entry to the industry, and identify the constraints to entry.

### **Output 3. Guidelines for planning and extension of small scale cage aquaculture produced.**

Production of the final output is not intended until the end of project workshop in March 2000. A mid-term project meeting including researchers from Vietnam, AIT, the Bangladesh CAGES project, and Stirling University was planned for Vietnam in April 1999. However, due to administrative problems, the workshop has had to be postponed until the 1<sup>st</sup> International Symposium on Cage Aquaculture in Asia, to be held in Taiwan during 2<sup>nd</sup> – 6<sup>th</sup> November 1999.

#### *19.1 Achievements Against Logframe*

Work is progressing satisfactorily. However it is anticipated that the literature reviews will not be submitted for publication until August 1999, and not March 1999, as was envisaged in the logframe.

#### *19.2 Activities during Quarter*

Ken McAndrew visited Bangladesh from 22<sup>nd</sup> March to 23<sup>rd</sup> April, and Vietnam from 23<sup>rd</sup> April until 1<sup>st</sup> May. Work included information exchange, editing and cataloguing of research Trials, planning of future research priorities and improving linkages of the project both within (NFEP-2) and out-with (University of Fisheries, Vietnam) Bangladesh.

Stuart Bunting worked on improving the CAGES database between 24<sup>th</sup> March and 15<sup>th</sup> April.

Paul Bulcock conducted his M.Sc. field work in Bangladesh between 24<sup>th</sup> March and 8<sup>th</sup> May.

Malcolm Beveridge assessed the overall research strategy while visiting Bangladesh on 6<sup>th</sup> and 7<sup>th</sup> April.

#### *19.3 Dissemination Outputs During Current Quarter*

All Trials conducted at the CAGES Research farm have been catalogued and a copy (both in electronic and hard form) placed at CBHQ and all regional CAGES offices.

All Trials that were conducted and written up in the farmer/ NGO field have been formatted and catalogued and a copy (both in electronic and hard form) placed at CBHQ and all regional CAGES offices.

Workshops on ‘Statistical Methods and the Use of Excel’ and ‘Hapa breeding of tilapia’ have been written up and are available through CARE – CAGES. The information on hapa breeding of tilapia has also been distributed to a total of 52 NGOs who intend to use this seed production system this year.

M.Sc. theses entitled ‘Problems associated with cages and cage-based aquaculture in Bangladesh’ has been written up and is in the process of being assessed. An article has been submitted to Aquaculture News, describing the background to the research and the activities carried out.

## **20 Planned Activities for next Quarter**

No visits to Bangladesh are planned in the next quarter. Time will be spent writing up results and publishing in a wide variety of sources.

### **Planned Modifications to Project Implementation (e.g. outputs, logframe etc.)**

The training of CAGES staff is not stated in the logframe. However, it was felt that the computing skills of staff, with the exception of MS WORD, were poor and that training would greatly benefit staff development and project outputs. Due to its success, more IT training is planned on each of Mr McAndrew’s subsequent visits.

Improvements in the CAGES database was deemed necessary by CAGES staff, as the previous version involved complex data collection, was difficult to analyse and was inaccessible to most staff. To properly monitor and evaluate project progress it was necessary to improve and simplify the database.

## **21 Dissemination Outputs Expected Next Quarter**

Literature reviews of small-scale cage aquaculture in both Bangladesh and Vietnam will be submitted to a peer-reviewed publication. In addition, key issues arising from the reviews will be discussed in a separate publication involving both countries.

From the information now available in the documented Trials, an output will be produced with guidelines of recommended technical practices for resource-poor cage farmers in Bangladesh for a range of species. The output will be in a loose-leaf format so that contents can be up-dated as better information becomes available.

A leaflet will be produced for farmers/ NGOs on ‘hapa breeding of tilapia’, published jointly by the IoA, CARE – CAGES and NFEP-2.

Publication of the results of Paul Bulcock’s M.Sc. thesis in a peer reviewed journal.



An interim progress report on the work in Vietnam will be completed. Report on the first phase of a comprehensive appraisal of feed supply issues, detailing the quantity, quality, prices and sustainability of existing feed supply to marine cage culture in Khanh Hoa

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**22.1 Highlights of Achievements**

- ?? During this quarter no visits to Bangladesh took place, and work was confined to following up on the previous visits.
- ?? Mr Kenneth McAndrew was interviewed and accepted for the job of CARE – CAGES Co-ordinator. His place on R7100 will be taken by Mr Paul Bulcock from 1<sup>st</sup> September, 1999.
- ?? The hapa breeding of tilapia leaflet, which is a joint output between IoA, CARE and NFEP-2, has been completed with final corrections agreed by all parties. Leaflets are currently being printed, before disseminated to farmers.
- ?? The M.Sc. project, which was carried out investigating an isopod parasite that had reportedly caused serious economic loss to cage farmers in Khulna district, Bangladesh was passed by examiners at the IoA. A copy of the thesis has been sent to CARE and the Fishmongers Company London.
- ?? The CAGES database manager continues to receive training on the use of Access.

**22.2 Progress Towards Outputs**

Output 1. The current status and characteristics of the small scale cage aquaculture sector in Asia assessed.

**Bangladesh**

A draft version of this has recently been completed by Ken McAndrew and is now being commented upon and improved by key people in the Bangladesh fisheries sector.

**23 Vietnam**

A draft review of marine cage culture in Vietnam has been completed by John Hambrey and will be presented at the 1<sup>st</sup> International Symposium on Cage Culture in Asia, Tungkang, Taiwan, November 1999. The review draws on existing literature as well as rapid appraisal of existing marine cage culture in Vietnam.

Output 2. Technological, economic, social and institutional context for small scale cage aquaculture development assessed for two regional locations (Bangladesh and Vietnam).

**24 Bangladesh**

Abstracts sent and writing begun on four separate papers to be presented at the 1<sup>st</sup> Symposium on Cage Aquaculture in Asia to be held in Taiwan from 2-6<sup>th</sup> November. Two of these papers are being written by CARE staff with support from R7100, while 2 papers are being authored by IoA staff, with one of these being a joint output between the Bangladesh and Vietnam components of the research project.

In December 1998, Ms Brugere, in close co-ordination with CAGES staff, established three social surveys. A draft paper detailing findings is currently being finalised for publication in *Aquaculture Asia*

## 25 Vietnam

**(Output: by end of project local sector reviews completed for seed and feed sources for cage culture)**

### 25.1.1 Seed

A first draft (in Vietnamese) of Lobster seed supply in Khanh Hoa has been completed.

### 25.1.2 Feed

**A second draft (in Vietnamese) of an assessment of *feed supply* in Khanh Hoa province is nearing completion. Nutritional and chemical analysis of some major trash fish species has been completed. Nutritional requirements of potential aquaculture species are being reviewed.**

## 25.2 *Alternative species*

**(Output: By the end of the project assessment of sustainability of alternative mariculture species completed).**

**(Activity: Assessment of comparative economics, resource profiles, and overall sustainability of alternative species for cage mariculture. This will include comparison with brackish pond culture of grouper, shrimp and crab)**

A first draft of a report on the market for live marine fish and crustaceans has been completed (Vietnamese). Economic, financial, risk, resource use/environmental profiles of existing and alternative marine cage culture species are being further developed.

Hatchery models (financial/production) of seabass, grouper, seahorse have been developed. These models generate financial indicators, and simple sustainability indicators relating to resource use and investment requirements. They will be used as the basis for a broad appraisal of the strengths and weaknesses of alternative aquaculture development options in terms of potential social, economic and environmental impact.

A paper on global trends in terms of input cost and supply, and market value of marine fin-fish will be presented to the 1<sup>st</sup> International Symposium on Cage Culture in Aquaculture in Taiwan in November. This will serve as the basis for a broader appraisal of the comparative advantage of Vietnam in terms of marine fin-fish production, and the long term sustainability of marine fin-fish production in the country.

## 25.3 *Institutional Analysis and Participatory Rural Appraisal*

**(Output: By end of project institutional analysis and PRA with farmers / communities completed)**

**(Activity: Rapid appraisal of all relevant institutions; a comprehensive institutional analysis carried out; participatory rural appraisal with cage farmers and the communities in which they are based.)**

### **25.3.1 Institutional analysis**

A first draft report on institutional analysis, based mainly on a workshop with major institutions, and PRA with farmers and fish farmers is in preparation.

### **25.3.2 Participatory Rural Appraisal**

A second draft report (in Vietnamese) on the PRA work has just been completed and will be translated shortly.

### ***Output 3. Guidelines for planning and extension of small scale cage aquaculture produced.***

Production of the final output is not intended until the end of project workshop in March 2000. A mid-term project meeting including researchers from Vietnam, AIT, the Bangladesh CAGES project, and Stirling University was planned for Vietnam in April 1999. However, due to administrative problems, the workshop has had to be postponed until the 1<sup>st</sup> International Symposium on Cage Aquaculture in Asia, to be held in Taiwan during 2<sup>nd</sup> – 6<sup>th</sup> November 1999.

### *25.4 Institutional Strengthening*

The project is laying strong emphasis on facilitation of local research, and strengthening links between researchers, farmers, extension workers and planning and development institutions. Already, through the surveys, the PRA and the local workshops, there is heightened awareness of the complex issues relating to aquaculture development, poverty alleviation, and sustainability, and the need for more integrated approaches.

The relationship between Scientists at AIT and from Scotland and those in Khanh Hoa Province Vietnam is also proving stimulating and enriching to all parties

### *25.5 Achievements Against Logframe*

Work is progressing satisfactorily. However it is anticipated that the literature reviews will not be submitted for publication until October 1999, and not March 1999, as was envisaged in the logframe.

### *25.6 Activities during Quarter*

### *25.7 Dissemination Outputs During Current Quarter*

## **26 Bangladesh**

*M.Sc. thesis on “Investigations into the biology of an unidentified isopod affecting the CERE CAGES aquaculture programme, Bangladesh” was submitted and passed, and in addition won the external examiners prize for best thesis*

*Mc Andrew 1999 “Research Support to the CARE CAGES Project in Bangladesh” published in Aquaculture News No. 25, July 1999, an IoA Publication.*

*The following abstracts have been written and will be presented at the 1<sup>st</sup> International Symposium on Cage Aquaculture in Asia.*

*John Hambrey, Le Anh Tuan, Nguyen Trong Nho, Do Thi Hoa, Ta Khac Thuong, Ken McAndrew, Cecile Brugere, Ziaul Huque, Khaleda Yesmin, and Mark Ireland 1999. Social And Economic Constraints To Entry and Success in Small Scale Fresh Water And Marine Cage Culture in Bangladesh And Vietnam*

*K. M. Kabir and Ziaul Huque 1999. Cage Design in the CARE –CAGES Project, Bangladesh. CARE – CAGES Project, Dhaka, Bangladesh. CARE CAGES report*

*Ken McAndrew, David Little and Malcolm Beveridge 1999. Implications of cage adoption in support of pond aquaculture production in Asia.*

*Shyamal Kanti Barman and Md. Suruj Ali 1999. Identification of Appropriate Feed And Feeding Techniques For Small-Scale Cage Aquaculture. Experiences from the CARE – CAGES Project, Bangladesh. CARE – CAGES Project, Dhaka, Bangladesh. CARE CAGES report*

## **27 Vietnam**

**The following articles have been written for publication:**

*Hambrey, J.B., Nho, N.T., Tuan, L.A., Hoa, D.T., Thuong, T.K. 1999. Poverty Alleviation and Marine Cage Culture in Vietnam (social, economic and institutional issues). AARM Newsletter, Bangkok, Thailand. Vol 4 No. 2 April 1999.*

*Hambrey, J.B., Nho, N.T., Tuan, L.A., Hoa, D.T., Thuong, T.K. 1999. Poverty Alleviation and Marine Cage Culture in Vietnam (seed and feed supply). Aquaculture News. Institute of Aquaculture. University of Stirling. In press.*

*Hambrey, J.B. 1999. Global prospects for cage aquaculture of finfish: input costs, market value, and comparative advantage. To be presented at the 1<sup>st</sup> International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. (proceedings will be published with full papers).*

*Tuan, L A, and Hambrey, J.B. 1999 “Sustainability of grouper seed supply to the aquaculture industry in Khanh Hoa, Vietnam”. Submitted to Asia Aquaculture.*

*Tuan, L A and Hambrey, J.B. 1999. Status of cage mariculture in Vietnam. To be presented as a “country paper” at the 1<sup>st</sup> International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. (proceedings will be published with full papers)*

## **28 Planned Activities for next Quarter**

## **29 Bangladesh**

While at the IoA Paul Bulcock's main activity will be to support publication of key findings of the CARE project by providing literature and statistical help with paper writing.

Paul Bulcock is expected to visit Bangladesh in late November/ early December 1999, for 4-5 weeks. While they're key activities will include

- ?? Assessing opportunities and constraints in the CARE-CAGES project
- ?? Writing up and documenting current NGO/ farmer Trials
- ?? A communication based on Paul Bulcock's M.Sc thesis is to be submitted to The Journal of Fish Diseases.

**30**

### **31 Vietnam**

**Regional guidelines** for development specialists and policy makers are being developed in collaboration with the Bangladesh component. These are likely to include the following components:

- ?? *Checklist* for the assessment of cage aquaculture potential;
- ?? *Development and communication techniques* – a brief introduction/overview and assessment of strengths and weaknesses;
- ?? *Policy initiatives for cage culture development* - a brief introduction/overview and assessment of strengths and weaknesses;
- ?? *Development profiles*: standardised summaries of technology, site requirements, production parameters, resource use and risk profiles of selected alternative cage aquaculture options (these will be *examples* which may serve as the starting point for the development of a comprehensive regional handbook);

### **Planned Modifications to Project Implementation (e.g. outputs, logframe etc.)**

As last quarter

### **32 Dissemination Outputs Expected Next Quarter**

Literature reviews of small-scale cage aquaculture in both Bangladesh and Vietnam will be submitted to a peer-reviewed publication. In addition, key issues arising from the reviews will be discussed in a separate publication involving both countries.

#### **Bangladesh**

From the information now available in the documented Trials, an output will be produced with guidelines of recommended technical practices for resource-poor cage farmers in Bangladesh for a range of species. The output will be in a loose-leaf format so that contents can be up-dated as better information becomes available.

A leaflet will be produced for farmers/ NGOs on 'hapa breeding of tilapia', published jointly by the IoA, CARE – CAGES and NFEP-2.

#### **Vietnam**

**The following articles are proposed:**

Comparative economics and sustainability of different coastal aquaculture options (Journal of Aquaculture Economics and Management – target submission date March 2000);

Alternative feed formulations and feeding strategies for marine cage culture in tropical countries (Fish Nutrition? Naga? Target submission date – March 2000)

**33 Other Comments.**

**Vietnam**

*33.1 Project management and Administration*

Most of the administrative problems previously reported have been overcome. The local project officer has taken on the role of local collaborator and project manager.

*33.2 Finance*

Funding for more comprehensive and effective writing up of project findings in academic and more practical formats is urgently required. This relates in particular to the costs involved in translation and final assimilation, writing and editing and of materials in English.

*34 Budget*

The project continues to run close to budget.

We have requested some increased funds for the final year to allow for more effective writing up of research outputs (see January Report).

35 Progress During Current Quarter

35.1 Highlights of Achievements

- ?? During this quarter one visit to Bangladesh took place, issues to be concentrated upon included the writing up and completion of trials implemented last year. Additionally the training of TOs and NGOs on trial methods and reporting was conducted. Discussions with CAGES co-ordinator on finalised literature review and content of R7100 technical report. The assessment of potential peer reviewed papers and articles took place.
- ?? The hapa breeding of tilapia leaflet, which is a joint output between IoA, CARE and NFEP-2, has been completed and will be disseminated to farmers.
- ?? Four papers Cage design in Bangladesh, Entry points and low risk strategies appropriate for the resource poor to participate in cage aquaculture. Experiences from the CARE-CAGES project, Bangladesh, Status of cage mariculture in Vietnam and Global prospects for cage aquaculture of finfish: input costs, market value, and comparative advantage were presented at the 1<sup>st</sup> Symposium on Cage Aquaculture in Asia held in Taiwan from the 26<sup>th</sup> November. The subjects of these presentations were a result of assistance by R7100 or authored by IoA, AIT and R7100 staff.

35.2 Progress Towards Outputs

**Output 1. The current status and characteristics of the small scale cage aquaculture sector in Asia assessed.**

A final version of this has recently been completed by Ken McAndrew and is now being commented upon during this R7100 visit.

**Output 2. Technological, economic, social and institutional context for small-scale cage aquaculture development assessed for two regional locations (Bangladesh and Vietnam).**

36 Bangladesh

- ?? Two separate papers were presented at the 1<sup>st</sup> Symposium on Cage Aquaculture in Asia held in Taiwan from the 26<sup>th</sup> November.
- ?? Cage design in Bangladesh,
- ?? .Entry points and low risk strategies appropriate for the resource poor to participate in cage aquaculture. Experiences from the CARE-CAGES project



These papers have been written by CARE staff with support from R7100, or authored by IoA and R7100 staff.

A

A paper titled *Is Poor Growth Expressed By the Common Carp (Cyprinus carpio) under CARE CAGES culture due to nutritional or other factors. A Case Study*, is being finalised for publication.

?? In December 1998, Ms Brugere, in close co-ordination with CAGES staff, established three social surveys. A draft paper detailing findings is currently being finalised for publication in *Aquaculture Asia*. The publication of this paper is required and R7100 will contact Ms Brugere to finalise draft and submit for publication.

?? A paper based on Mr Bulcock's M.Sc project on the Investigation of Isopod pathogen in Jessore region is to be produced, proposed to be submitted to *The Journal of Fish Diseases*. A draft will be prepared between himself and the IoA's Professor Christina Sommerville over the Christmas period.

### ***36.1 Activities during Quarter***

During the current Bangladesh visit During this quarter one visit to Bangladesh took place (Appendix 1) for itinerary, issues to be concentrated upon included the writing up and completion of trials implemented last year. These will be added to the catalogue of previous trials implemented by R7100 and referred to extensively by CAGES. Additionally the training of TOs and NGOs on trial methods, reporting of these trials and the importance of raw data for valid analysis was conducted. Discussions with CAGES co-ordinator on finalised literature review and content of final R7100 technical report also took place with Chapter titles and potential content and format being considered, plus work on producing papers for peer review publication.

A presentation By Ken McAndrew took place entitled, *Fish health Risks to Small-scale Cage Farmers in Bangladesh with Emphasis on Fish Health. Experiences of the CARE-CAGES Project* took place

### ***36.2 Dissemination Outputs During Current Quarter***

?? A leaflet has been produced for farmers/ NGOs on 'hapa breeding of tilapia', published jointly by the IoA, CARE – CAGES and NFEP-2. Written in Bangla, the leaflet is currently in press and will be disseminated to farmers.

?? From the writing of completed trials during this R7100 visit the CAGES trial catalogue has been updated and the findings of trials made available to all regions and associated NGOs.

- ?? A paper titled Fish health Risks to Small-scale Cage Farmers in Bangladesh with Emphasis on Fish Health. Paper was presented at an FAO/ NACA/ DFID regional workshop on Primary Aquatic Animal Health care in Rural Aquaculture Development workshop, Dhaka, Bangladesh. Experiences of the CARE-CAGES Project.

**37 Planned Activities for next Quarter**

- ?? Finalisation of R7100 Technical report, based on activities and outputs including an assessment of impact of R7100 on CAGES programme Bangladesh.
- ?? Workshop for the Guidelines for planning and extension of small scale cage aquaculture to occur.

**Planned Modifications to Project Implementation (e.g. outputs, logframe etc.)**

**38 Dissemination Outputs Expected Next Quarter**

- ?? Literature review of small-scale cage aquaculture in Bangladesh will be submitted to a peer-reviewed publication. In addition, key issues arising from the reviews will be discussed in a separate publication involving both countries.
- ?? Final R7100 technical report
- ?? From the information now available in the documented Trials, an output will be produced with guidelines of recommended technical practices for resource-poor cage farmers in Bangladesh for a range of species. The output will be in a loose-leaf format so that contents can be up-dated as better information becomes available. Final economic and technical details will be compiled at the CARE CAGES retreat in mid Jan 2000.
- ?? A paper titled Is Poor Growth Expressed By the Common Carp (*Cyprinus carpio*) under CARE CAGES Culture Due to Nutritional Or Genetic factors. A Case Study, is being finalised for peer review publication.

39 Vietnam

40 Activities and outputs September to December 1999

40.1 *An assessment of current status and characteristics of the small scale cage aquaculture sector in Asia*

**(Output: By March 1999 a comprehensive multidisciplinary literature review of small scale cage culture in inland and coastal areas of Asia submitted for peer review publication).**

A draft review of marine cage culture in Vietnam has been completed and was presented at the 1<sup>st</sup> International Symposium on Cage Culture in Asia, Tungkang, Taiwan, November 1999. The review draws on existing literature as well as rapid appraisal of existing marine cage culture in Vietnam.

This will be used, along with the review of cage culture being prepared by the Bangladesh component of the project, as the basis for a more general review of cage culture and the major issues relating to its development and implications for poverty alleviation.

40.2 *Sector reviews of feed and seed sources*

**(Output: by end of project local sector reviews completed for seed and feed sources for cage culture)**

40.2.1 Seed

A first draft (in Vietnamese) of Lobster seed supply in Khanh Hoa has been completed.

40.2.2 Feed

A second draft (in Vietnamese) of an assessment of *feed supply in Khanh Hoa province* is nearing completion. Nutritional and chemical analysis of some major trash fish species has been completed. Nutritional requirements of potential aquaculture species are being reviewed.

40.3 *Alternative species*

**(Output: By the end of the project...assessment of sustainability of alternative mariculture species completed).**

**(Activity: Assessment of comparative economics, resource profiles, and overall sustainability of alternative species for cage mariculture. This will include comparison with brackish pond culture of grouper, shrimp and crab)**

A first draft of a report on the market for live marine fish and crustaceans has been completed (Vietnamese). Economic, financial, risk, resource use/environmental profiles of existing and alternative marine cage culture species are being further developed.

Hatchery models (financial/production) of seabass, grouper, seahorse have been developed. These models generate financial indicators, and simple sustainability indicators relating to resource use and investment requirements. They will be used as the basis for a broad appraisal of the strengths and weaknesses of alternative

aquaculture development options in terms of potential social, economic and environmental impact.

A paper on global trends in terms of input cost and supply, and market value of marine finfish was presented to the 1<sup>st</sup> International Symposium on Cage Culture in Aquaculture in Taiwan in November.

#### **40.4 Institutional Analysis and Participatory Rural Appraisal**

**(Output: By end of project institutional analysis and PRA with farmers / communities completed)**

**(Activity: Rapid appraisal of all relevant institutions; a comprehensive institutional analysis carried out; participatory rural appraisal with cage farmers and the communities in which they are based.)**

##### **40.4.1 Institutional analysis**

A first draft report on institutional analysis, based mainly on a workshop with major institutions, and PRA with farmers and fish farmers is in preparation.

##### **40.4.2 Participatory Rural Appraisal**

A second draft report (in Vietnamese) on the PRA work has just been completed and will be translated shortly.

#### **41 Outputs – general**

##### **41.1 Publications**

**The following articles have been written for publication:**

- ?? Hambrey, J.B. 2000. Global prospects for cage aquaculture of finfish: input costs, market value, and comparative advantage. Presented at the 1st International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. (proceedings will be published with full papers).
- ?? Tuan, L A, and Hambrey, J.B. 1999 “Sustainability of grouper seed supply to the aquaculture industry in Khanh Hoa, Vietnam”. Submitted to Asia Aquaculture.
- ?? Tuan, L A and Hambrey, J.B. 2000. Status of cage mariculture in Vietnam. Presented as a “country paper” at the 1st International Symposium on Cage Aquaculture in Asia, Tungkang Marine laboratory, Taiwan, 2-6<sup>th</sup> November 1999. (proceedings will be published with full papers)

**The following articles are proposed:**

- ?? A review of cage aquaculture in SE Asia. With rest of cages team, and drawing on Vietnam and Bangladesh country reviews + latest information presented at Taiwan cages conference.
- ?? Hambrey J.B. and L.A. Tuan. Comparative economics and sustainability of different coastal aquaculture options (Journal of Aquaculture Economics and Management-target submission date March 2000).
- ?? Williams K, Tuan L.A and J.B Hambrey. Alternative feed formulations and feeding strategies for marine cage culture in Vietnam (Fish Nutrition? Naga? Target submission date-March 2000).
- ?? Marine cage culture of finfish: can it contribute to poverty alleviation in tropical developing countries. One of the development journals?

### **Output 3. Guidelines for planning and extension of small scale cage aquaculture produced.**

**Regional guidelines** for development specialists and policy makers will be developed as a joint output of the Bangladesh and Vietnam components at the end of project workshop. These are likely to include the following:

- ?? *Checklist* for the assessment of cage aquaculture potential;
- ?? *Development and communication techniques* – a brief introduction/overview and assessment of strengths and weaknesses;
- ?? *Policy initiatives for cage culture development* - a brief introduction/overview and assessment of strengths and weaknesses;
- ?? *Development profiles*: standardised summaries of technology, site requirements, production parameters, resource use and risk profiles of selected alternative cage aquaculture options (these will be *examples* which may serve as the starting point for the development of a comprehensive regional handbook);

Production of the final output is not intended until the end of project workshop. The CAGES co-ordinator proposes a date in February 2000 although discussion is required between partners to finalise this date. The workshop location is Bangladesh with a specific site to be arranged.

#### **41.2 Achievements against Logframe**

Work is progressing satisfactorily. However it is anticipated that the Bangladesh literature review will not be submitted for publication until Jan 2000, and not March 1999, as in the logframe.

#### **42 Other Comments**

43 Bangladesh

44 With the implementation of low risk strategies and appropriate entry points suggested by R7100 and currently being undertaken by CAGES there is scope for further work by R7100

Bangladesh

Institutional consultant required by CAGES programme to examine and advise on the monitoring and evaluation of performance of partner NGOs. CAGES enquire whether project R7100 is in a position to fund such a study.

Vietnam

#### **44.1 Finance**

Vietnam

Funding for more comprehensive and effective writing up of project findings in academic and more practical formats is urgently required. This relates in particular to the costs involved in translation and final assimilation, writing and editing and of materials in English.

**45 Budget**

The project continues to run close to budget.

We have requested some increased funds of approximately £3000 for the final year to allow for more effective writing up of research outputs.

### **Bangladesh**

- ?? During this quarter no visits to Bangladesh took place, instead issues to be concentrated upon included the writing up and completion of on-farm trials implemented last year. These included preliminary trials examining low risk over-wintering strategies a more appropriate entry point to the participation of the rural resource poor to small-scale cage aquaculture systems.
- ?? Outputs in the form of papers for peer reviewed journals were produced and submitted.
- ?? Preliminary results from the on-farm trials concerned with low risk strategies are being assessed such as the use of the over-wintering of semibrood and fry to fingerling stage.

### **Vietnam**

- ?? *An assessment of current status and characteristics of the small scale cage aquaculture sector in Asia is being used, along with the review of cage culture prepared by the Bangladesh component of the project, as the basis for a more general review of cage culture. Examining the major issues relating to its development and implications for poverty alleviation and entitled social and economic constraints to success in small-scale cage culture in Asia.*
- ?? **A working paper on feed supply in Khanh Hoa province has been completed (in English). An Australian specialist (Dr Kevin Williams of CSIRO) undertook a short consultancy in lobster and marine finfish nutrition, and possible alternative feed sources and composition. A comprehensive report has been submitted to the project.**
- ?? Economic, financial, risk, resource use/environmental profiles of existing and alternative marine cage culture species are being further developed to be completed at the final CAGES workshop 9<sup>th</sup> to the 11<sup>th</sup> July in Dhaka.
- ?? A second draft report (in Vietnamese) on PRA work been completed and will be translated.

### **Combined**

#### **Guidelines for planning and extension of small scale cage aquaculture produced.**

**Regional guidelines** for development specialists and policy makers will be developed as a joint output of the Bangladesh and Vietnam components at the end of project workshop (July 9<sup>th</sup> -11<sup>th</sup> 2000). These include the following:

- 1) Checklist for the assessment of cage aquaculture potential.
- 2) Development and communication techniques.
- 3) Policy initiatives for cage culture development - a brief introduction/overview and assessment of strengths and weaknesses.
- 4) Development profiles: standardised summaries of technology, site requirements, production parameters, resource use and risk profiles of selected alternative cage aquaculture options.

A preliminary schedule including timetable, activities and role of participants has been circulated to all members for amendments and agreement on final format.

### **Dissemination**

- 1) Brugere C, Mc Andrew K.I & Bulcock P. 2000. *Does cage aquaculture address gender goals in development: A case study*, submitted and currently under review by the Journal of Aquaculture economics and management
- 2) Brugere C, McAndrew K.I & Bulcock P 2000. *Social impacts of cage aquaculture on communities in Bangladesh*, Aquaculture Asia, in press.
- 3) Bulcock P & Brugere C. 2000. *Identifying research needs in adoption of cage culture, Bangladesh*. Aquaculture News no 26 pp 7 -9.
- 4) A non-technical paper on the sustainability of grouper seed supply in Khanh has been submitted to NAGA (ICLARM Quarterly). A working paper (in Vietnamese) of Lobster seed supply in Khanh Hoa has been completed.



**46 Progress During Current Quarter**

**Highlights of the Bangladesh and Vietnam components.**

Guidelines for planning and extension of small-scale cage aquaculture have been produced. These guidelines for development specialists and policy makers were developed as an output of the Bangladesh and Vietnam components at the end of project workshop (July 9 -11<sup>th</sup> 2000), CARE Guest House, Dhanmondi and included:

- ?? Checklist for the assessment of cage aquaculture potential.
- ?? Development and communication techniques.
- ?? Policy initiatives for cage culture development - a brief introduction/overview and assessment of strengths and weaknesses.
- ?? Development profiles: standardised summaries of technology, site requirements, production parameters, resource use and risk profiles of selected alternative cage aquaculture options.

Attended by 41 delegates representing all R7100 collaborative institutions, Bangladesh academic institutions and development organisations. Through a combination of plenary discussion, individual presentations and group exercises these were produced. The proceedings of the workshop have been produced and will be disseminated to all participants and other associated institutions.

The final technical report '*The Improved Management of Small-Scale cage culture in Asia*' is currently in production outlining the activities of Project R7100, findings and contribution towards DFID developmental goals.

**Vietnam**

A summary workshop was conducted in Vietnam on the July 5<sup>th</sup> to 7<sup>th</sup> consisting of the findings of the Vietnam component of R7100 and conducted through paper presentation and group discussion, contributing towards outputs at the final CAGES workshop in Dhanmondi, Dhaka. The proceedings of this workshop are available in the form of papers in both English and Vietnamese and will be disseminated to collaborative and associated institutions.

**Dissemination**

- ?? Proceedings of the final R7100 workshop to be disseminated to workshop participants and other related institutions.
- ?? Proceedings of the Vietnam workshop, papers produced in English and Vietnamese, to be disseminated to collaborative and related institutions.
- ?? Is poor growth expressed by the common carp under CARE CAGES culture due to nutritional effects, accepted for review for The Journal of Applied Aquaculture

**Future Dissemination**

- ?? The final R7100 technical report 'The Improved Management of Small-Scale Cage Culture in Asia' currently in production to be disseminated to collaborative and associated institutions.
- ?? Social and economic constraints to entry and success in small-scale cage culture in Bangladesh and Vietnam to be submitted to The Journal of Aquaculture Economics and Management.
- ?? Poverty reduction and small-scale cage aquaculture in Asia-A review of development in Bangladesh. To be submitted to Aquaculture Asia.

## **VI. *Extension and training materials***

### **a) The hapa-breeding of tilapia (*Oreochromis niloticus*)**

**This leaflet is not available electronically, but can be obtained from the Project Leader.**

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## ***VII. Final workshop report***

***The Improved Management of Small-Scale Cage Culture in Asia (DFID Research Project R7100): Final Workshop***

***9<sup>th</sup> – 11<sup>th</sup> July 2000***

***CARE Guest House, Road 7A, Dhanmondi, Dhaka, Bangladesh***

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***Executive Summary***

*The two-year, DFID-funded CAGES-II Project R7100, 'The Improved Management of Small-Scale cage Culture in Asia', is due for completion in August 2000. The purpose of the project is to develop sustained small-scale cage fish culture in inland and coastal waters through improved understanding of the social, institutional and resource environment of resource poor groups. Two Asian countries, Bangladesh (inland systems) and Vietnam (marine), were studied with this workshop bringing together both sides of the project together with representatives of collaborative institutions, government departments and universities. Addressing the overall aim of producing guidelines for the planning and extension of cage aquaculture in Asia a combination of group work and plenary discussion was conducted producing the following outputs. 1) An assessment of cage aquaculture potential, 2) Development options for small-scale cage culture, 3) A review of tools and methodologies and 4) Policy initiatives for sustainable cage culture development. Key issues raised were the use of outputs as a guide to be adapted to regional circumstances to facilitate farmer and extension worker discussion and not as a rigid methodology. The degree of linkage between development, research and government institutions was also considered a crucial factor in benefiting the research and development of cage culture at the local, regional and national level and vital in affecting the future policies by both development and government institutions.*

## 46.2 BACKGROUND

Cage aquaculture is one of the fastest growing methods of farmed fish and crustacean production in Asia. Because it utilises publicly owned resources, requires small amounts of capital investment and has a rapid return on investment, it is an option for resource poor farmers. However, there are many issues to be resolved concerning beneficiaries, technologies, methods and policies, as well as the most appropriate approaches to research.

**The purpose of the two-year, DFID-funded CAGES -II Project R7100 is to develop sustained small-scale cage fish culture in inland and coastal waters through the improved understanding of the social, institutional and resource environment of resource poor groups. Guidelines for the planning and extension of small-scale aquaculture are required as stated with the project's Logical Framework Appendix (1) to be achieved via the use of an end of project workshop.**

This workshop aimed to pull together research and development practitioners from Bangladesh, Vietnam, the UK and Thailand who were working in aquaculture development and who had specific interests in cage aquaculture. The aim being to produce a toolkit for field extension staff to encourage sustainable development of this sector of the rural economy.

## 46.3 WORKSHOP ORGANISATION

The three-day workshop consisted of various sessions, which comprised formal presentations, group and plenary sessions and a field visit to a cage culture project (see Appendix 2 for detailed timetable). Attended by 46 delegates from Bangladesh, the U.K, Thailand and Vietnam representing NGOs, government departments and academic institutions the workshop had a wide multi-disciplinary array of knowledge at its disposal, utilised in the compilation of this report

### REPORT STRUCTURE

This report outlines the guidelines required, via four outputs;

1. The assessment of cage culture potential
2. The production of development options
3. A review of the research tools and methodologies used in project R7100
4. Policy initiatives for sustainable cage culture development

For each section an outline of the methodologies involved and the intended outputs are given, followed by the outputs themselves and relevant appendixes.



## 1. ASSESSMENT OF CAGE AQUACULTURE POTENTIAL

Chair Paul Bulcock

### Objective

- ?? to identify categories of possible constraints to farmer uptake;
- ?? to identify particular constraints within the categories;
- ?? to develop an appropriate ranking and scoring system(s) to assess cage culture potential.

### Output

- ?? A checklist/scoring system for NGOs and extension workers that can serve as a basis for identification of potential beneficiaries and technology packages.

47

### 48 Method

- ?? *initial presentation outlining the aim and intended outputs of this session;*
- ?? *plenary discussion session to identify categories of constraints and opportunities*
- ?? *small group-based discussions to identify constraints and opportunities;*
- ?? presentations and plenary discussions on small group findings;
- ?? *small group-based discussions to identify ranking and scoring systems*
- ?? presentations and plenary discussions on small group findings.

## **Introduction**

Past attempts to use cage culture for the benefit of the rural resource poor have failed primarily due to the inadequate consideration of the social, technical, economic and institutional context of potential beneficiaries. Extension workers and development projects must give consideration to these particular factors and in discussion with farmers decide whether cage culture is appropriate to their situation and needs. The aim of this component of the project was to identify the main categories of constraint that would form the backbone for discussion.

## **Output**

The main categories identified by the participants as crucial to the discussion process between the farmer and extension worker the extension officer when assessing the potential for small-scale cage culture were identified and grouped under the four types outlined below

- ?? Needs Assessment
- ?? Site Selection
- ?? Inputs
- ?? Outputs

Within each category, individual criteria were identified, and it is through a consideration and discussion of these criteria that the farmer and extension worker can determine the validity of small-scale low input cage culture. Using this, or a similar checklist based upon it, it is hoped that an informed decision on the validity of cage culture as an alternative Income Generating Activity (IGA) can be made.

It was decided that it would be unsuitable to rank or score the constraints and criteria as farmer priorities and situations vary; rather they should serve as a 'basis for discussion'. From the use of this checklist combined with the farmer's knowledge of his environment, livelihood and local resources the farmer and extension worker can determine whether cage culture is both an appropriate and viable IGA. Following this, a consideration of the profiles outlined in section 2 can be made identifying which, if any, are most suited to the circumstances of farmers.

**A checklist for NGOs and extension workers**

**Needs Assessment**

<i>Key Constraints</i>	<i>Criteria</i>
<b>Target group selection</b>	?? Depends on criteria of project
<b>The level of interest in cage culture expressed by the farmer</b>	?? The lack of alternative aquaculture options ?? The level of demand for fish and amount of supply ?? The level of alternative employment options

**48.1.1.1 Site Selection**

<i>Key constraints</i>	<i>Criteria</i>
<b>Access</b>	?? Cost of access ?? Security of tenure
<b>Suitability</b>	?? The year round level of water ?? The water quality ?? Access to input and output sources
<b>Vulnerability</b>	?? The susceptibility to climate hazards ?? Proximity of cages to household <sup>1</sup> ?? The level of security provided by other community members <sup>2</sup>

**48.1.1.2**

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<sup>1</sup>(Bangladesh) The risk of poaching increases with distance of cages from household

<sup>2</sup>(Bangladesh) Single women operators suffer more theft

### 48.1.1.3 Inputs

<i>Key constraints</i>	<i>Criteria</i>
Finance	?? The level of access to capital and operating costs <sup>3</sup>
Labour	?? The Household division of tasks <sup>4</sup> ?? Community division of tasks ?? The seasonal division of labour
Knowledge and Skills	?? The current level of skills and knowledge i.e. the level of farmers experience ?? The amount of access to skills and knowledge i.e. extension services.
Cage Materials	?? Local availability ?? Quality and cost of these materials
Seed	?? Local availability ?? Quality and cost of these materials
Feed	The level of access to: ?? Natural feed sources ?? Kitchen by-products ?? Agricultural by-products ?? Village waste ?? Other by-products, such as hotel and abattoir wastes
Competition	?? The degree of competition for these inputs with other resource users and the potential conflicts which may arise.

### 48.1.1.4

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<sup>3</sup>Less important in Bangladesh than Vietnam where costs are lower and as project works through NGOs most farmers have access to micro-credit. However financial management by farmers of loans is considered a problem. As farmer generally more than is required and finds repayment difficult.

<sup>4</sup>(Bangladesh) Children participate in feed gathering, Women feed preparation and application, Men marketing and selection of fingerlings

#### 48.1.1.5 Outputs

<i>Key Constraints</i>	<i>Criteria</i>
<b>Markets</b>	?? Intended market for product <sup>5</sup> and access to markets
<b>Environmental</b>	?? Is the environmental capacity suitable and what will the effects of this activity on it <sup>6</sup>
<b>Social</b>	?? Will a positive or negative change in livelihood and social status be produced

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<sup>5</sup>The sale of live fish is common and can result in higher returns.

<sup>6</sup>Fish escapes are common and the impacts of non-indigenous species e.g. *Oreochromis niloticus* should be considered. Benthos degradation should be determined, such as the production of Hydrogen Sulphide (H<sub>2</sub>S) in permanent water bodies and increasing the risk of fish kills. Other potential resource conflicts should also be addressed such as the introduction of cages or navigation and other livelihoods such as fishermen. Consideration of alternative uses of inputs such as feed and the effects of an increase in demand should also be considered.

## **2. DEVELOPMENT OPTIONS FOR SMALL-SCALE CAGE CULTURE**

*Chair*            Malcolm Beveridge

### **Objective**

?? to develop an understanding of the resources necessary to the sustained development of cage aquaculture for resource poor farmers in rural Asia.

### **Output**

?? a series of cage profiles of small-scale marine and freshwater cage culture, based on Vietnam and Bangladesh;

?? decision trees to help identify cage culture packages appropriate to on-farm and environmental resources of the rural poor.

### **Method**

?? initial presentation outlining the aim and intended outputs of this session;

?? group-based (4) discussions to identify Outputs 1 and 2 for both marine and freshwater cage systems;

?? presentations and plenary discussion of outputs.

## **48.2**

### **48.3 Cage Profiles**

#### **48.4 Introduction**

Once cage aquaculture has been identified as a potential benefit via discussion centred on the checklist described in Section One, the selection of a cage culture technology that fits an individual's needs can be made. In order to assist future planners and development workers in this task summary profiles were constructed for inland and coastal systems Appendices (2i; 2ii) and from a consideration of the major constraints outlined in the checklist decision trees were produced Appendix (2iii; 2iv and 2v).

#### **48.5 Summary profiles of cage culture systems currently used in Asia**

The profiles, Appendix (2i) and Appendix (2ii) summarise key features of different cage aquaculture systems currently in use in Asia. The information on each sheet is derived from practical examples drawn from different parts of the region. All quantities and values have been scaled to 1m<sup>3</sup> of cage volume.

?? The information is indicative only: the actual figures (both production parameters and financial values) are snapshots of the current situation in Bangladesh and Vietnam and vary widely according to local circumstances.

?? *The Tables Are Informed Estimates of Average Performance, Based on Project Data, Discussions with Farmers and Discussions with CARE and UoF Technical Staff. Actual Costs and Returns, and the Relative Attractiveness of Different Cage Culture Options, will vary Widely According to the Cost, Availability and quality of Labour, Seed and Feed; the Nature and Size of the Local Market; and the Knowledge and Skill of Farmers.*

?? *The profiles should therefore serve as a basis for discussion and the values and figures should be examined critically and adapted accordingly.*

?? Only the major necessary costs of capital investment (cages only), seed, feed and labour are included. Other costs (such as equipment, medicines, fuel etc) are likely to vary enormously from location to location and according to the scale of enterprise. The returns given are therefore generally higher than would be achieved in practise.

?? The inland (Appendix 2i) and coastal (Appendix 2ii), profiles are considered under into five main sections Key features, Input/Outputs, Risk Profiles, Market Outlook and notes Appendix (2).

##### **48.5.1.1.1**

## Appendix (2) Summary features of cage profiles.

These brief summary profiles can be sub-divided into five groups:

### 1) *Key features*

**This section is largely self-explanatory, and summarises key features in terms of site requirements, start-up costs, markets, and risk.**

?? **For *temperature and salinity* three figures are given: the upper and lower values of the range within which commercial rates of growth can take place and the optimum value.**

?? **For *water quality requirement* three ratings are given: low, medium and high. Almost all fish grow better in high water quality, but some fish are more tolerant of low water quality – at least in the short term. Low water quality is defined here as water with oxygen content regularly <3 mg/l, low transparency (<5 cm) (high concentrations of nutrients; high organic matter loadings). Medium water quality is defined as water with 3-5 mg/l oxygen; transparency <30 cm. High water quality is defined as >5 mg/l oxygen, transparency >30 cm.**

?? ***Capital costs* are related to costs of materials and size of cage.**

?? ***Profit* is the difference between input costs and sales revenue. In practice profit would normally be less than this figure, since only costs of labour, feed, and seed are considered.**

?? ***Gross margin* This represents the net money generated by the operator once inputs are accounted for, excluding labour and cage depreciation. The major factor influencing decisions concerning small-scale cage culture is gross margin versus labour input and investment risk.**

?? ***Return on labour* is the labour rate (U.S \$/day) that would reduce profit to zero. It is an indication of how much of the revenue generated is available to pay for labour.**

?? ***Scale* issues. What are the most likely immediate effects of expansion on cage culture profile?**

48.5.1.1.1.38



#### 1.1.1.1.1 2) Input/Output

?? The investment in terms of feed, seed and labour required for a typical system and the resulting returns in terms of production and potential financial returns

#### 3) Risk Profiles

?? *Risk rating.* This is a composite index based on an assessment and consideration of the following factors: the prevalence and impact of diseases, the length of the production cycle, minimum start-up capital required, profit margin, price variation and payback period.

?? *Length of the production cycle* (months) is an indicator of financial risk. A shorter cycle means that the capital invested is at risk for a shorter period of time. Where more than one cycle is possible in a year (depending on availability of water and the temperature regime) this implies a more regular income.

?? *Minimum start-up capital* gives an indication of the minimum total capital and working capital investment required before the first crop is harvested. This includes only the cost of the cage and the working capital requirements in terms of feed and seed for the first crop. The figure is based on the smallest viable system currently in use. It should be noted that operators of such small systems (with low labour productivity) may find it difficult to compete with larger enterprises (with high labour productivity) as production increases and prices (typically) fall. Effective organisation of small-scale producers may help to overcome this problem.

?? *Profit margin* is the ratio of profit to sales revenue, and is an important indicator of vulnerability to falling product price or rising input costs. In Bangladesh this is given for systems including and excluding labour costs, as cage culture activities are often incorporated into household activities, affording little opportunity costs.

?? *Payback period* This represents the number of production cycles required to pay off the start-up investment, assuming that all gross margin earnings were used for this purpose.

**4) Market outlook**

?? A brief overview of the *market* is provided in terms of the strength of demand in national and international markets. If the market is large and international, prices are likely to remain fairly stable despite increased aquaculture production. If the market is small and specialised, significant aquaculture production is likely to depress prices.

**1.1.1.1.2 5) Notes**

?? Notes identify the principle assumptions made regarding the formation of these profiles with respect to capital costs, seed, feed and labour.

?? Notes include outlines of why in Bangladesh examples of profit margin and payback period are given including and excluding labour.

**Appendix 2i. Cage culture profile for inland systems<sup>1</sup>**

CAGE CULTURE PROFILE			
Tilapia culture, Bangladesh, commercial feed			
location	Bangladesh	cycles/yr	2
cage size	1 m <sup>3</sup>	risk	low
species	<i>Oreochromis niloticus</i>	return	medium
<b>Key features</b>		<b>Input/output profile (per m<sup>3</sup> per cycle)</b>	
<i>environmental requirements</i>			
salinity	0-20 ppt	inputs	quantity \$
water quality	>low	capital costs/cycle	1.8
temperature	>25	seed	4.0
<i>investment cost</i>		feed	10.0
capital costs	7	labour (day)	14 10.8
capital costs/m <sup>3</sup> cage	7	<i>outputs</i> kg \$	
life of cage	2	fish	28.0
<i>financial returns/cycle</i>		organic matter	/
profit/m <sup>3</sup>	1	nitrogen	/
gross margin/m <sup>3</sup>	12	<i>total costs per crop</i> 26.6	
return on labour	1	<i>total revenue per crop</i> 28.0	
Scale issues	increase in no. of cages will reduce labour requirements	<b>Market outlook</b>	
<b>Risk profile</b>		local	medium
disease incidence	low	national	low
length of production cycle (months)	3.5	international	low
minimum start-up capital (\$)	21	<b>Notes</b>	
investment in one crop (\$)	27	Capital costs, Cost of cage materials only	
profit margin (%)	5	Seed, hatchery reared, 90% survival	
profit margin (excluding labour) (%)	44	Feed, Commercial pellets when available	
price variation	low	Labour is calculated at agricultural rates of 40 Tka /day (\$ 0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.	
payback period (cycles)	14.5		
payback period(excluding labour) (cycles)	1.7		
comment	disease may increase		
overall	low		

<sup>1</sup> The profiles are estimates of average performance based on project data, discussions with farmers, and with CARE staff. Actual costs and returns and the relative attractiveness of different cage culture options will vary widely according to the cost, availability and quality of labour, seed and feed, the nature and size of the local market, and the knowledge of the farmer.

## 48.6

<b>CAGE CULTURE PROFILE</b>			
<b>Tilapia culture, Bangladesh, natural and commercial supplemental feed</b>			
<i>location</i>	Bangladesh	<i>cycles/yr</i>	2
<i>cage size</i>	1 m <sup>3</sup>	<i>risk</i>	low
<i>species</i>	<i>Oreochromis niloticus</i>	<i>return</i>	medium
<b>Key features</b>		<b>Input/output profile (per m<sup>3</sup> per cycle)</b>	
<i>environmental requirements</i>		<i>inputs</i> <i>quantity</i> <i>\$</i>	
<i>salinity</i>	0-20 ppt	capital costs/cycle	1.8
<i>water quality</i>	>low	seed	4.0
<i>temperature</i>	>25	feed	4.0
<i>investment cost</i>		labour (day)	19
capital costs	7	<i>outputs</i> <i>kg</i> <i>\$</i>	
capital costs/m <sup>3</sup> cage	7	fish	26.0
life of cage	2	organic matter	/
<i>financial returns/cycle</i>		nitrogen	/
profit/m <sup>3</sup>	1	<i>total costs per crop</i> 24.8	
gross margin/m <sup>3</sup>	17	<i>total revenue per crop</i> 26.0	
return on labour	1		
Scale issues	increase in no. of cages will reduce labour requirements		
<b>Risk profile</b>		<b>Market outlook</b>	
disease incidence	low	local	medium
length of production cycle (months)	3.5	national	low
minimum start-up capital (\$)	15	international	low
investment in one crop (\$)	25		
profit margin (%)	5		
profit margin (excluding labour) (%)	63		
price variation	low		
payback period (cycles)	12.0		
payback period(excluding labour) (cycles)	0.9		
comment	disease may increase		
<i>overall</i>	low		
<b>Notes</b>			
Capital costs, Cost of cage materials only			
Seed, hatchery reared, 90% survival			
Feed, Commercial pellets when available plus locally available items			
Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.			

**CAGE CULTURE PROFILE**

**Tilapia culture, Bangladesh, natural feed**

location	Bangladesh	cycles/yr	2
cage size	1 m <sup>3</sup>	risk	low
species	<i>Oreochromis niloticus</i>	return	low

Key features	
<i>environmental requirements</i>	
salinity	0-20 ppt
water quality	>low
temperature	>25
<i>investment cost</i>	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	2
<i>financial returns/cycle</i>	
profit/m <sup>3</sup>	-3
gross margin/m <sup>3</sup>	18
return on labour	1
Scale issues	increase in no. of cages will reduce labour requirements

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		1.8
seed	200	4.0
feed	0	0.0
labour (day)	26	20.8
<hr/>		
outputs	kg	\$
fish		24.0
organic matter	/	
nitrogen	/	
<hr/>		
<i>total costs per crop</i>		26.6
<hr/>		
<i>total revenue per crop</i>		24.0

Risk profile	
disease incidence	low
length of production cycle (months)	3.5
minimum start-up capital (\$)	11
investment in one crop	27
profit margin (%)	-11
profit margin (excluding labour) (%)	76
price variation	low
payback period (cycles)	-4.3
payback period (excluding labour) (cycles)	0.6
comment	disease may increase
<i>overall</i>	low

Market outlook	
local	medium
national	low
international	low

**Notes**  
 Capital costs, Cost of cage materials only  
 Seed, hatchery reared, 90% survival  
 Feed locally available items  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

CAGE CULTURE PROFILE			
Grass carp culture, Bangladesh, fed a supplemental commercial feed			
location	Bangladesh	cycles/yr	1
cage size	1 m <sup>3</sup>	risk	low
species	<i>Ctenopharyngodon idella</i>	return	medium
<b>Key features</b>		<b>Input/output profile (per m<sup>3</sup> per cycle)</b>	
<i>environmental requirements</i>		<b>inputs</b>	
salinity	0 ppt	quantity	\$
water quality	high	capital costs/cycle	1.8
temperature	>25	seed /	12.0
<i>investment cost</i>		feed /	3.0
capital costs	7	labour (day)	30
capital costs/m <sup>3</sup> cage	7	<b>outputs</b>	
life of cage	3	kg	\$
<i>financial returns/cycle</i>		fish	50.0
profit/m <sup>3</sup>	2.4	organic matter /	
gross margin/m <sup>3</sup>	33	nitrogen /	
return on labour	1	<b>total costs per crop</b>	
Scale issues	increase in no. of cages will reduce labour requirements		40.8
<b>Risk profile</b>		<b>Market outlook</b>	
disease incidence	low	local	medium
length of production cycle (months)	8	national	low
minimum start-up capital (\$)	22	international	low
investment in one crop (\$)	41		
profit margin (%)	17		
profit margin (excluding labour) (%)	65		
price variation	low		
payback period (cycles)	2.5		
payback (excluding labour) (cycles)	0.7		
comment	disease may increase		
<b>overall</b>	low		
<b>Notes</b>			
Capital costs, accounts for costs of cage materials			
Seed, Hatchery reared, 90% survival.			
Feed, High protein sources incurs high cost unless local alternative sources can be found			
Labour An increase in the number of cages per enterprise will greatly reduce labour rerequirements			
Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.			

**CAGE CULTURE PROFILE**

Grass carp culture, Bangladesh, fed a natural feed

location	Bangladesh	cycles/yr	1
cage size	1 m <sup>3</sup>	risk	low
species	<i>Ctenopharyngodon idella</i>	return	medium

Key features	
<i>environmental requirements</i>	
salinity	0 ppt
water quality	high
temperature	>25
<i>investment cost</i>	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	3
<i>financial returns/cycle</i>	
profit/m <sup>3</sup>	3.3
gross margin/m <sup>3</sup>	35
return on labour	1
Scale issues	increase in no. of cages will reduce labour requirements

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		1.8
seed	/	12.0
feed	/	1.0
labour (day)	40	32.0
outputs	kg	\$
fish		50.0
organic matter	/	
nitrogen	/	
<i>total costs per crop</i>		46.8
<i>total revenue per crop</i>		50.0

Risk profile	
disease incidence	low
length of production cycle (months)	8
minimum start-up capital (\$)	52
investment in one crop (\$)	47
profit margin (%)	7
profit margin (excluding labour) (%)	71
price variation	low
payback period (cycles)	6.2
payback (excluding labour) (cycles)	0.6
comment	disease may increase
<i>overall</i>	low

Market outlook	
local	medium
national	low
international	low

**Notes**  
 Capital costs, accounts for costs of cage materials  
 Seed. Hatchery reared, 90% survival.  
 Feed. High protein sources incurs high cost unless local alternative sources can be found  
 Labour An increase in the number of cages per enterprise will greatly reduce labour requirements  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

**Silver barb culture, Bangladesh fed a commercial feed.**

<i>location</i>	Bangladesh	<i>cycles/yr</i>	2
<i>cage size</i>	1 m <sup>3</sup>	<i>risk</i>	low
<i>species</i>	<i>Puntius gonionotus</i>	<i>return</i>	medium

<b>Key features</b>	
<i>environmental requirements</i>	
salinity	0 ppt
water quality	high
temperature	>25
<i>investment cost</i>	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	2
<i>financial returns/cycle</i>	
profit/m <sup>3</sup>	7
gross margin/m <sup>3</sup>	18
return on labour	1
Scale issues	increase in no. of cages will reduce labour requirements

<b>Input/output profile (per m<sup>3</sup> per cycle)</b>		
<i>inputs</i>	<i>quantity</i>	<i>\$</i>
capital costs/cycle		1.8
seed		7.0
feed		10.0
labour	14	10.8
<i>outputs</i>	<i>kg</i>	<i>\$</i>
fish		36.0
organic matter	/	
nitrogen	/	
<i>total costs per crop</i>		29.6
<i>total revenue per crop</i>		36.0

<b>Risk profile</b>	
disease incidence	low
length of production cycle (months)	3.5
minimum start-up capital (\$)	24
investment in one crop (\$)	30
profit margin (%)	19
profit margin (excluding labour) (%)	49
price variation	low
payback period (cycles)	3.4
payback period (excluding labour) (cycles)	1.3
comment	disease may increase
<i>overall</i>	low

<b>Market outlook</b>	
local	medium
national	low
international	low

**Notes**  
 Capital costs, Cost of cage materials only  
 Seed, hatchery reared, 90% survival  
 Feed, Commercial pellets when available  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.



<b>CAGE CULTURE PROFILE</b>			
<b>Silver barb culture, Bangladesh fed a natural feed, plus supplemental commercial feed.</b>			
<i>location</i>	Bangladesh	<i>cycles/yr</i>	2
<i>cage size</i>	1 m <sup>3</sup>	<i>risk</i>	low
<i>species</i>	<i>Puntius gonionotus</i>	<i>return</i>	medium
<b>Key features</b>		<b>Input/output profile (per m<sup>3</sup> per cycle)</b>	
<i>environmental requirements</i>			
salinity	0 ppt	inputs	quantity
water quality	high	capital costs/cycle	\$ 1.8
temperature	>25	seed	7.0
		feed	2.0
<i>investment cost</i>		labour (day)	19
capital costs	7		
capital costs/m <sup>3</sup> cage	7	<b>outputs</b>	
life of cage	2	fish	kg \$ 30.0
		organic matter	/
<i>financial returns/cycle</i>		nitrogen	/
profit/m3	4	<i>total costs per crop</i>	
gross margin/m3	20	25.8	
return on labour	1		
Scale issues	increase in no. of cages will reduce labour requirements	<i>total revenue per crop</i>	
		30.0	
<b>Risk profile</b>		<b>Market outlook</b>	
disease incidence	low	local	medium
length of production cycle (months)	3.5	national	low
minimum start-up capital (\$)	16	international	low
investment in one crop (\$)	26		
profit margin (%)	16		
profit margin (excluding labour) (%)	66		
price variation	low		
payback period (cycles)	3.4		
payback period (excluding labour) (cycles)	0.8		
comment	disease may increase		
overall	low		
<b>Notes</b>			
Capital costs, Cost of cage materials only			
Seed, hatchery reared, 90% survival			
Feed, naturally available items when available plus suppl commercial feed			
Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.			

**CAGE CULTURE PROFILE**

Silver barb culture, Bangladesh, fed a natural feed.

location	Bangladesh	cycles/yr	2
cage size	1 m <sup>3</sup>	risk	low
species	<i>Puntius gonionotus</i>	return	medium

<b>Key features</b>	
environmental requirements	
salinity	0 ppt
water quality	high
temperature	>25
investment cost	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	2
financial returns/cycle	
profit/m <sup>3</sup>	-3
gross margin/m <sup>3</sup>	18
return on labour	1
Scale issues	increase in no. of cages will reduce labour requirements

<b>Input/output profile (per m<sup>3</sup> per cycle)</b>		
inputs	quantity	\$
capital costs/cycle		1.8
seed		7.0
feed		0.0
labour (day)	26	20.8
outputs	kg	\$
fish		26.0
organic matter	/	
nitrogen	/	
total costs per crop		29.6
total revenue per crop		26.0

<b>Risk profile</b>	
disease incidence	low
length of production cycle (months)	3.5
minimum start-up capital (\$)	14
investment in one crop (\$)	30
profit margin (%)	-12
profit margin (excluding labour) (%)	68
price variation	low
payback period (cycles)	-4.3
payback period (excluding labour) (cycles)	0.8
comment	disease may increase
overall	low

<b>Market outlook</b>	
local	medium
national	low
international	low

**Notes**  
 Capital costs, Cost of cage materials only  
 Seed, hatchery reared, 90% survival  
 Feed, naturally available items when available  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

**CAGE CULTURE PROFILE**

Pangas culture, Bangladesh, commercial feed.

location	Bangladesh	cycles/yr	1
cage size	1 m <sup>3</sup>	risk	low
species	<i>Pangasius sutchii</i>	return	medium

Key features	
<i>environmental requirements</i>	
salinity	0 ppt
water quality	high
temperature	>25
<i>investment cost</i>	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	3
<i>financial returns/cycle</i>	
profit/m <sup>3</sup>	28
gross margin/m <sup>3</sup>	52
return on labour	2
Scale issues	increase in no. of cages will reduce labour requirements

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		2.3
seed		7.0
feed		54.0
labour (day)	30	24.0
outputs	kg	\$
fish	35	115.0
organic matter	/	
nitrogen	/	
<i>total costs per crop</i>		87.3
<i>total revenue per crop</i>		115.0

Risk profile	
disease incidence	low
length of production cycle (months)	9
minimum start-up capital (\$)	68
investment in one crop (\$)	87
profit margin (%)	24
profit margin (excluding labour) (%)	49
price variation	low
payback period (cycles)	2.4
payback period (excluding labour) (cycles)	1.3
comment	disease may increase
<i>overall</i>	<i>medium</i>

Market outlook	
local	medium
national	low
international	low

**Notes**  
 Capital costs. accounts for costs of cage materials  
 Seed, Hatchery reared, 90% survival.  
 Feed, High protein sources incurs high cost unless local alternative sources can be found  
 Labour An increase in the number of cages per enterprise will greatly reduce labour rerequirements  
 Labour is calculated at agricultural rates of 40 Tka /dav (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

**CAGE CULTURE PROFILE**

**Pangas culture, Bangladesh supplemental commercial feed.**

location	Bangladesh	cycles/yr	1
cage size	1 m <sup>3</sup>	risk	low
species	<i>Pangasius sutchii</i>	return	medium

<b>Key features</b>	
<i>environmental requirements</i>	
salinity	0 ppt
water quality	high
temperature	>25
<i>investment cost</i>	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	3
<i>financial returns/cycle</i>	
profit/m <sup>3</sup>	18
gross margin/m <sup>3</sup>	50
return on labour	1
Scale issues	increase in no. of cages will reduce labour requirements

<b>Input/output profile (per m<sup>3</sup> per cycle)</b>		
inputs	quantity	\$
capital costs/cycle		2.3
seed		7.0
feed		27.0
labour (day)	40	32.0
<i>outputs</i>		
	kg	\$
fish		86.4
organic matter	/	
nitrogen	/	
<i>total costs per crop</i>		68.3
<i>total revenue per crop</i>		86.4

<b>Risk profile</b>	
disease incidence	low
length of production cycle (months)	9
minimum start-up capital (\$)	41
investment in one crop (\$)	68
profit margin	21
profit margin (excluding labour) (%)	58
price variation (%)	low
payback period (cycles)	2.3
payback period (excluding labour) (cycles)	0.8
comment	disease may increase
<i>overall</i>	medium

<b>Market outlook</b>	
local	medium
national	medium
international	low

**Notes**  
 Capital costs, accounts for costs of cage materials  
 Seed, Hatchery reared, 90% survival.  
 Feed, High protein sources incurs high cost unless local alternative sources can be found  
 Labour An increase in the number of cages per enterprise will greatly reduce labour rerequirements  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

**CAGE CULTURE PROFILE**

Grass carp culture, Bangladesh, nursing.

location	Bangladesh	cycles/yr	1
cage size	1 m <sup>3</sup>	risk	low
species	<i>Cteneparyngodon idella</i>	return	medium

Key features	
<i>environmental requirements</i>	
salinity	0 ppt
water quality	high
temperature	>25
<i>investment cost</i>	
capital costs	7
capital costs/m <sup>3</sup> cage	7
life of cage	4
<i>financial returns/cycle</i>	
profit/m3	-11.2
gross margin/m3	12
return on labour	0.6
Scale issues	increase in no. of hapas will reduce labour requirements

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		1.8
seed		6.0
feed	/	4.0
labour (day)	30	24.0
<hr/>		
outputs	kg	\$
fish		50.0
organic matter /		
nitrogen /		
<hr/>		
<i>total costs per crop</i>		35.8
<hr/>		
<i>total revenue per crop</i>		24.0

Risk profile	
disease incidence	low
length of production cycle (months)	8
minimum start-up capital (\$)	17
investment in one crop (\$)	36
profit margin (%)	-49
profit margin (excluding labour) (%)	51
price variation	low
payback period (cycles)	-1.4
payback (excluding labour) (cycles)	1.4
comment	disease may increase
<i>overall</i>	low

Market outlook	
local	medium
national	low
international	low

**Notes**  
 Capital costs, accounts for costs of cage materials  
 Seed, Hatchery reared, 90% survival.  
 Feed, High protein sources incurs high cost unless local alternative sources can be found  
 Labour An increase in the number of cages per enterprise will greatly reduce labour rerequirements  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

**CAGE CULTURE PROFILE**

**Pangas culture, Bangladesh nursing**

location	Bangladesh	cycles/yr	2
cage size	1 m <sup>3</sup>	risk	low
species	<i>Pangasius sutchii</i>	return	medium

Key features	
<i>environmental requirements</i>	
salinity	0 ppt
water quality	high
temperature	>25
<i>investment cost</i>	
capital costs	8
capital costs/m <sup>3</sup> cage	8
life of cage	2
<i>financial returns/cycle</i>	
profit/m3	59
gross margin/m3	71
return on labour	5
Scale issues	increase in no. of cages will reduce labour requirements

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		2.0
seed		40.0
feed		7.0
labour (day)	15	12.0
outputs	kg	\$
fish		120.0
organic matter	/	
nitrogen	/	
<i>total costs per crop</i>		61.0
<i>total revenue per crop</i>		120.0

Risk profile	
disease incidence	low
length of production cycle (months)	9
minimum start-up capital (\$)	55
investment in one crop (\$)	61
profit margin (%)	49
profit margin (excluding labour) (%)	59
price variation	low
payback period (cycles)	0.9
payback period (excluding labour) (cycles)	0.8
comment	disease may increase
<i>overall</i>	medium

Market outlook	
local	medium
national	low
international	low

**Notes**  
 Capital costs, accounts for costs of hapa materials  
 Seed, Hatchery reared, 90% survival.  
 Feed, High protein sources incurs high cost unless local alternative sources can be found  
 Labour An increase in the number of cages per enterprise will greatly reduce labour rerequirements  
 Labour is calculated at agricultural rates of 40 Tka /day (\$0.8). In practice, food gathering is often undertaken by children and or adults during the period of wage labour shortage.

## Appendix 2ii. Cage culture profiles for marine systems<sup>2</sup>

### 48.8

<b>CAGE CULTURE PROFILE</b>			
<b>Grouper culture Vietnam: single small cage</b>			
<i>location</i>	<i>Vietnam</i>	<i>cycles/yr</i>	<i>1</i>
<i>cage size</i>	<i>13.5 m<sup>3</sup></i>	<i>risk</i>	<i>low/medium</i>
<i>species</i>	<i>Epinephelus bleekeri</i>	<i>return</i>	<i>high</i>

<b>Key features</b>		<b>Input/output profile (per m<sup>3</sup> per cycle)</b>		
<i>environmental requirements</i>		<b>inputs</b>	<b>quantity</b>	<b>\$</b>
salinity	>25ppt	capital costs/cycle		4.6
water quality	high	seed	10	4.0
temperature	25-30	feed	48	9.6
<i>investment cost</i>		labour (day)	6	6.1
capital costs <sup>1</sup>	250	<b>outputs</b>		
capital costs/m <sup>3</sup> cage	19	fish	8	48.0
life of cage	4	organic matter	8	
<i>financial returns/cycle</i>		nitrogen	2.1	
profit/m <sup>3</sup>	24	<i>total costs per crop</i>		
gross margin/m <sup>3</sup>	30			24.3
return on labour	5	<i>total revenue per crop</i>		
Scale issues	expansion leads to significant increases in return related mainly to more efficient utilisation of labour			48.0

<b>Risk profile</b>		<b>Market outlook</b>	
disease incidence	<i>low</i>	local	medium
length of production cycle (months)	8	national	medium
minimum start-up capital (\$) 1	516	international	good in short/medium term
investment in one crop (\$) 1	329		
profit margin (%)	49		
price variation	low-medium		
payback period (years)	0.8		
comment	disease may increase		
<i>overall</i>	<i>low/medium</i>		

<b>Notes</b>	
<sup>1</sup> capital costs for a single cage	One 13.5m <sup>3</sup> cage. This is the smallest type of operation currently found in Khanh Hoa
seed	wild caught seed stocked at 150g; 80% survival
feed	trash fish caught locally or purchased in market
labour requirements	75 days/cycle typically used in Khanh Hoa; less for larger enterprises; feeding . (1 times/day); cage cleaning (removal of fouling).

<sup>2</sup> The profiles are estimates of average performance based on project data, discussions with farmers, and discussions with CARE staff. Actual costs and returns, and the relative attractiveness of different cage culture options, will vary widely according to the cost, availability and quality of labour, seed and feed, the nature and size of the local market, and the knowledge of the farmer.

**CAGE CULTURE PROFILE**

**Lobster rearing Vietnam: single small cage and small seed (50 g)**

location	Vietnam		cycles/yr	0.75
Cage size	13.5	m <sup>3</sup>	risk	medium
species	Macrobrachium		return	high
	rosenbergii			

Key features	
environmental requirements	
salinity	29-34
water quality	high
temperature	20-30
investment cost	
enterprise capital costs	292
capital costs/m3 cage	22
life of cage	4
financial returns/cycle	
profit/m3	78
gross margin/m3	100
return on labour	5
scale issues	expansion leads to significant increases in return related mainly to more efficient utilisation of labour

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		7.2
seed	10	20
feed	191	38
labour	20	22
outputs		
	kg	\$
fish	6.6	165
organic matter		
nitrogen		
total costs per crop		87
total revenue per crop		165

Risk profile	
disease incidence	low
length of production cycle (months)	18
minimum start-up capital (\$) <sup>1</sup>	1375
investment in crop (\$)	1180
profit margin (%)	47
price variation	low
payback period (years)	0.4
comment	disease may increase
overall	low/medium

Market outlook	
local	small, expanding
national	medium, expanding
international	excellent in short and long term

Notes	
<sup>1</sup> capital costs for a single cage	One 13.5m <sup>3</sup> cage. This is the smallest type of operation currently found in Khanh Hoa
seed	wild caught seed stocked at 50g; 60% survival
feed	trash fish or shellfish caught locally or purchased in market
labour requirements	270 person days/cycle typically used in Khanh Hoa; less for larger enterprises; feeding (2 times/day); cage cleaning (removal of fouling)



**CAGE CULTURE PROFILE**

Lobster rearing Vietnam: single small cage and large seed (200 g)

location	Vietnam	cycles/yr	1
Cage size	13.5 m <sup>3</sup>	risk	medium
species	<i>Panulirus ornatus</i> ; <i>P hormarus</i>	return	very high

Key features	
<i>environmental requirements</i>	
salinity	29-34
water quality	high
temperature	20-30
<i>investment cost</i>	
enterprise capital costs	292
capital costs/m3 cage	22
life of cage	4
<i>financial returns/cycle</i>	
profit/m3	109
gross margin/m3	119
return on labour	8
scale issues	expansion leads to significant increases in return related mainly to more efficient utilisation of labour

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		5.4
seed	10	45
feed	255	51
labour	14	15
outputs	kg	\$
fish	8.8	220
organic matter nitrogen		
<i>total costs per crop</i>		111
<i>total revenue per crop</i>		220

Risk profile	
disease incidence	low
length of production cycle (months)	12
minimum start-up capital (\$) <sup>1</sup>	1796
investment in crop (\$)	1504
profit margin (%)	49%
price variation	low
payback period (years)	0.2
comment	disease may increase
<i>overall</i>	low/medium

Market outlook	
local	small, expanding
national	medium, expanding
international	excellent in short and long term

Notes	
<sup>1</sup> capital costs for a single cage	One 13.5m <sup>3</sup> cage. This is the smallest type of operation currently found in Khanh Hoa
seed	wild caught seed stocked at 200g; 80% survival
feed	trash fish and shellfish caught locally or purchased in market
labour requirements	180 days/cycle typically used in Khanh Hoa; less for larger enterprises; feeding (2 times/day); cage cleaning (removal of fouling)

**CAGE CULTURE PROFILE**

**Seabass rearing Vietnam: feasibility model**

location	Thailand	cycles/yr	1
Cage size	13.5 m <sup>3</sup>	risk	medium
species	<i>Lates calcarifer</i>	return	medium/low

Key features	
<i>environmental requirements</i>	
salinity	10-34
water quality	medium
temperature	20-30
<i>investment cost</i>	
enterprise capital costs	250
capital costs/m3 cage	19
life of cage	4
<i>financial returns/cycle</i>	
profit/m3	0.1
gross margin/m3	6.1
return on labour	1.1
scale issues	expansion leads to significant increases in return related mainly to more efficient utilisation of labour

Input/output profile (per m <sup>3</sup> per cycle)		
inputs	quantity	\$
capital costs/cycle		4.6
seed (pc)	40	6.0
feed (kg)	84	16.8
labour (day)	6	6.1
outputs	kg	\$
fish	14	34
organic matter nitrogen		
<i>total costs per crop</i>		34
<i>total revenue per crop</i>		34

Risk profile	
disease incidence	medium
length of production cycle (years)	9
minimum start-up capital (\$) <sup>1</sup>	703
investment in crop (\$)	453
profit margin (%)	0.2%
price variation	medium
payback period (years)	312.5
<i>overall</i>	medium

Market outlook	
local	small, steady
national	slow expansion
international	medium, slow expansion
Seabass prices (farm gate) are currently \$2/kg or less in Vietnam, corresponding to a loss. However, with some domestic market development and access to international markets a farm gate price of \$2.5+ should be possible.	

Notes	
<sup>1</sup> capital costs for a single cage	One 13.5m <sup>3</sup> cage. This is the smallest type of operation currently found in Khanh Hoa
seed	hatchery seed at 12cm. Current Thai price around US\$.15 each
feed	trash fish or shellfish caught locally or purchased in market
labour requirements	assuming same labour requirements as for grouper. In practice may need more regular feeding

## **Appendix 2 iii. Decision Trees**

### **48.9.1.1 Introduction**

Discussion between the farmer and the extension officer should form the basis of whether to use decision trees in the selection of cage systems. The decision trees outlined describe the thought process in greater detail for both inland systems [Appendix (2iv)] and in more general terms for coastal cage culture in Bangladesh [Appendix (2v)] and Vietnam [Appendix (vi)]. Again, the criteria for assessment and priorities of the farmer will vary greatly from region to region as well as from farmer themselves and should only serve as a guide and not as a definitive version.

### **48.9.2 Freshwater Inland Systems**

The main criteria involved in the decision making process were identified as level of access to a waterbody i.e. whether limited or open, including the level afforded to female participants, the level of experience of participants the amount of capital available and seed supply. An example of how these criteria lead to the selection of particular systems through the use of a decision tree is shown in Appendix (2iv) based on the following considerations.

- ?? Access includes consideration of access for females. If only limited access is available then farming co-operatively is assumed more appropriate, this also means capital and input costs can be shared reducing the level of risk. If no access is available then cage culture is not appropriate.
- ?? If an individual's knowledge of cage culture is relatively low then the best option is the grow-out of fish; if it is greater, then more options are available (Hatchery/Nursery/Grow-out). If working co-operatively then skills can be shared leading to the adoption of a greater range of options.
- ?? If an appropriate level of finance is available then high input species can be considered, if finance is limited then low input should be considered.
- ?? Both wild caught and hatchery seed are available in Bangladesh, but access to these sources could be limited by both location and finance.

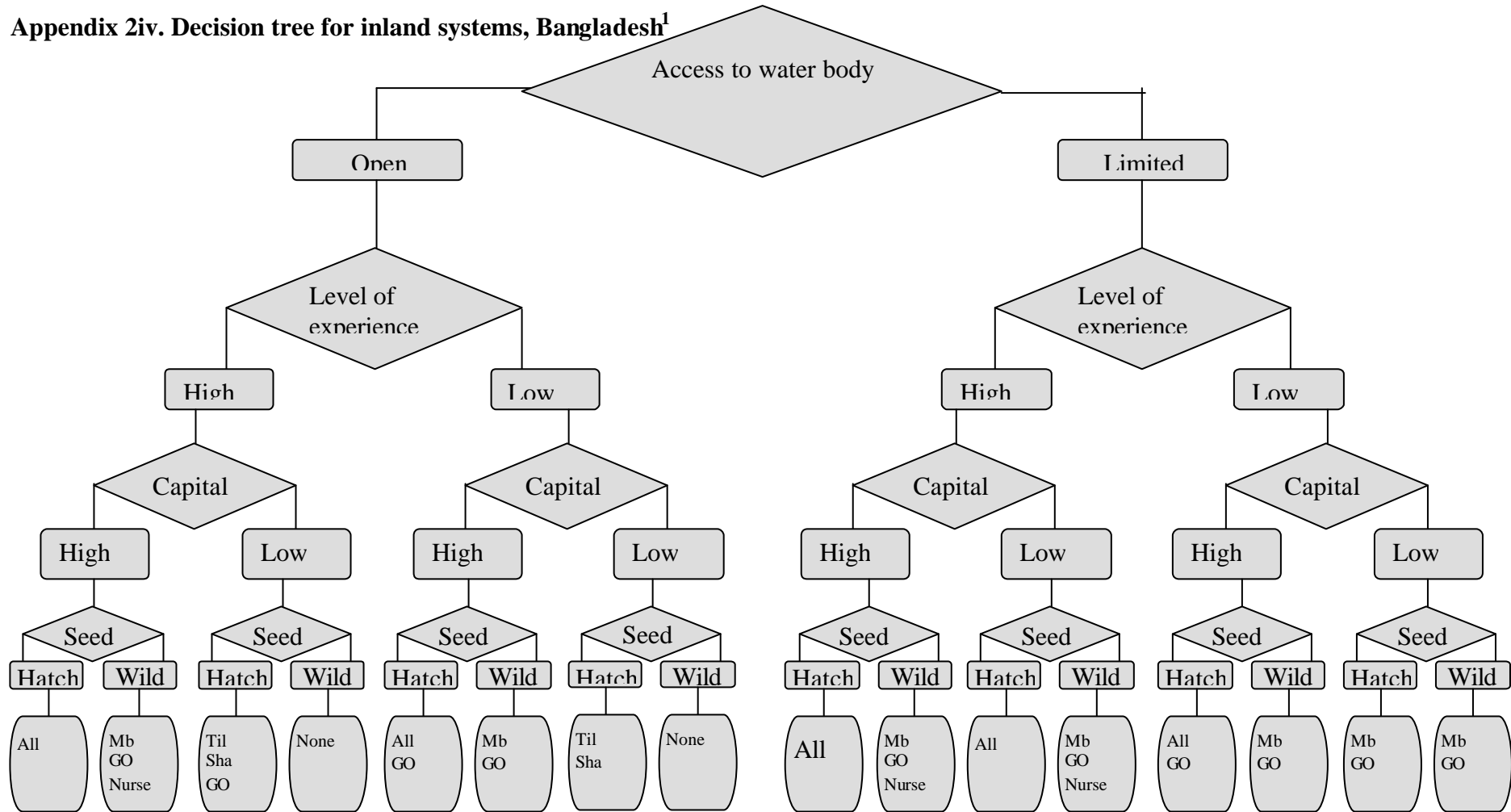
### **Marine Coastal Systems**

- ?? There are many practical and social aspects regarding access and control of coastal water bodies in Bangladesh and Vietnam that need to be discussed and resolved through use of the checklist (Section 1) before implementing the use of a decision tree. In Vietnam, the main question was then assumed to be with regard to access to finance Appendix (2vi). This contrasts with the situation in Bangladesh where access to finance is supplied through the micro-credit schemes

of NGOs and the investment costs themselves are much lower than in Vietnam, although these criteria may differ from farmer to farmer.



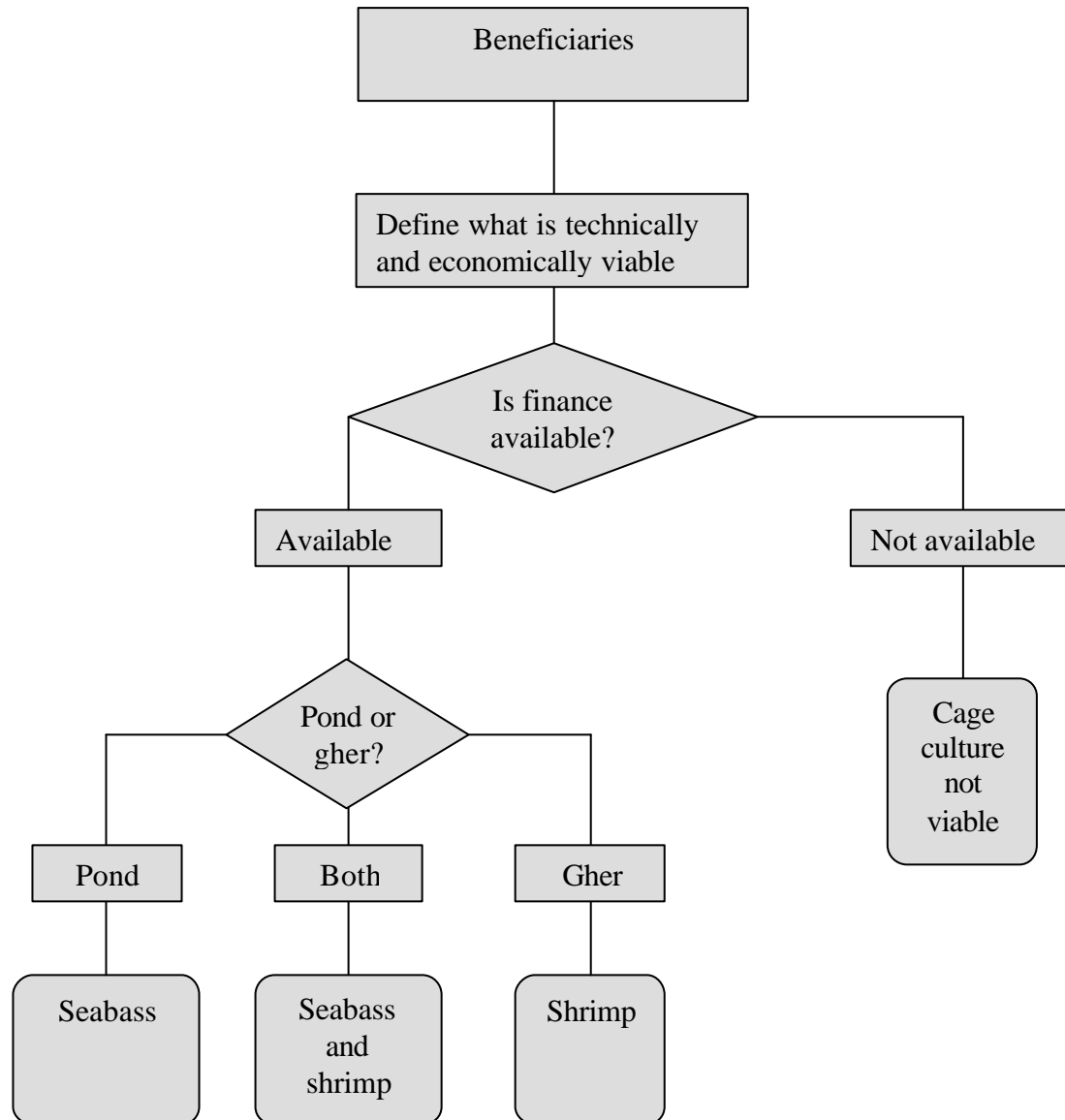
Appendix 2iv. Decision tree for inland systems, Bangladesh<sup>1</sup>



<sup>1</sup>GO:Grow-out, Nurse:Hapa nursing of fingerlings or postlarvae, All:*M. rosenbergii*, *Pangasius sutchii*,/pangasius *Oreochromis niloticus*, *Puntius gonionotus* growout & *M. rosenbergii* and *P. sutchii*/pangasius nursing, Mb:*Macrobrachium rosenbergii*, Til:Tilapia (*Oreochromis niloticus*), Sha:Sharputi (*Puntius gonionotus*), Hatch:, Hatchery reared seed, Wild: Wild caught seed.



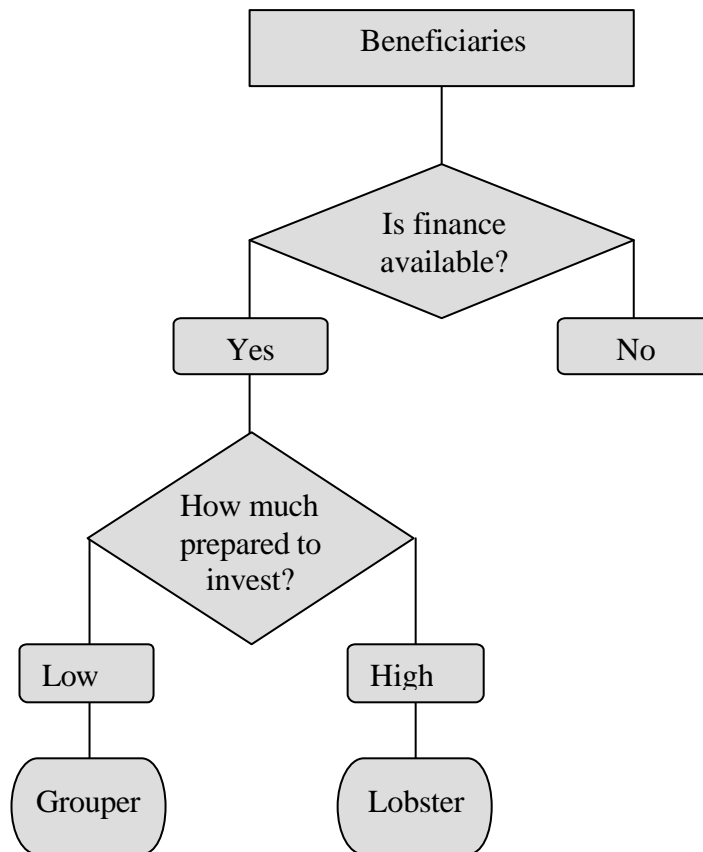
**Appendix 2v. Decision tree for coastal cage aquaculture, Bangladesh.**





48.9.2.1.1 Appendix 2vi.  
Vietnam

Decision tree for coastal cage culture,



### **3. REVIEW OF TOOLS AND METHODOLOGIES USED IN PROJECT R7100**

*Chair*            Kenny McAndrew

#### **Objective**

?? to review tools / methodologies used during project R7100 for identification of researchable constraints and communication of results to farmers and to produce recommendations for future projects in Asia.

#### **Output**

?? a critical review of tools and methodologies;

?? guidelines for the researcher, NGOs and extension workers on where, why, who and how various approaches are most appropriate.

#### **Method**

?? three presentations were made

?? Bangladesh                    Paul Bulcock

?? Vietnam                        Tuan/Thuong

?? General considerations    John Hambrey

?? plenary discussion of extension methodologies and production of guidelines.

## **Introduction**

Project R7100 utilised a range of research methods and approaches during the two-year lifetime that can now be assessed in terms of their effectiveness in benefiting both the research process and the rural resource poor. The recommendations are intended to benefit similar research and development projects throughout Asia.

## **Output**

The research approaches adopted by the Bangladesh and Vietnam components of R7100 are outlined in Appendix (3 i) and Appendix (3 ii) and detail the benefits and constraints of these approaches.

The group discussions that followed the presentations raised the following main points concerning the research methods utilised. Comments and suggestions for the improvement of the research process were made and are also summarised below.

48.9.2.2 Critical review of tools

- ?? **Participatory on-farm technical trials are a valuable way of gaining an indication of the validity of the option under examination and also serve to build the capacity of those involved. However due to the inevitable compromises in experimental design and the largely qualitative nature of the results generated, it was recommended that complementary on-station or other research be considered.**
- ?? **The use of participatory rural appraisal and rapid rural appraisal is essential in yielding crucial baseline information at the individual, community and regional level and raising topics for further research. The use of both techniques also not only increases awareness in communities on the role of research but also reduces tensions between community members and resource users. PRA is more beneficial in this respect due to the longer timeframe and its ability to raise awareness of the issues among different groups of resource users.**
- ?? **The use of these tools can therefore be said to incorporate an element of training or 'capacity building' among beneficiaries and those associated or collaborating with the research project. Indeed training can be seen as a vital component of the research process especially when carried out alongside an existing development project. This element of training could be expanded to include relevant NGOs and Government Officers.**
- ?? **Within Vietnam it is difficult to discern - apart from the capacity building of intended benefactors - where the advantages of the participatory rural appraisal conducted lie over rapid rural appraisal due to a decreasing return in knowledge on time invested.**
- ?? **The research process in Bangladesh would have benefited from the topics and approaches adopted in Vietnam, such as how cage culture compares with alternative livelihoods.**
- ?? **It was thus concluded that the ideal research approach may be a combination of the techniques utilised in both Bangladesh and Vietnam, incorporating on-farm trials, participatory and rapid rural appraisal approaches.**
- ?? **Linkage with other development, research and government organisations, as occurred within the present project, in which there was collaboration with the University of Fisheries, Vietnam, the Asian Institute of Technology, the CARE CAGES project and NFEP-2, Bangladesh, is vital. Collaborative efforts not only ensure a greater impact of research outputs in terms of beneficiaries but also add value to the research process. Further links with other national research institutions and government institutions, such as fisheries departments, would both increase the amount of expertise and disseminatory pathways available.**

*Guidelines for the researcher, NGOs and extension workers.*

- ?? The use of tools outlined in this section concentrated on research methods at the beneficiary level, in this case the rural resource poor and women, rather than the traditional approach of formulating research in isolation, followed by dissemination: a top-down approach. When time and resources allow, participatory rural appraisal should be utilised to obtain a more complete overview of the situation of these intended beneficiaries, through the use of direct and semi-structured interviews and group of exercises, especially when the intention is to build capacity rather than collect information.
- ?? **When time and resources are limited rapid rural appraisal should be used. Rapid rural appraisal is also particularly useful when working with existing development organisations, where research is demand led, identifying opportunities and constraints on which more focused research can be directed.**
- ?? **Where time and resources allow, linkages should be formed with other research and development institutions in order to share expertise and findings and take full advantage of existing frameworks and adding value to the research process identifying research needs and rapid dissemination of findings. Linkages are also likely to benefit the formulation of policy initiatives, as will be discussed in section 4.**
- ?? **If linkage to other institutions is secured, participatory methods such as on-farm research involving the rural poor in the development of suitable technologies can be utilised.**

Appendix 3. A Review of the Tools and Methodologies conducted by the Bangladesh component of Project R7100.

Paul Bulcock

Cage aquaculture is a relatively novel concept in Bangladesh with a brief and mostly unsuccessful history. Previous attempts at introducing the technology had failed, primarily due to the wholesale transfer of technology from other regions. To be successful cage culture must be appropriate to the technological, economic, social and institutional context of cage operators, in this instance the rural resource poor. The DFID funded research project R7100 'The Improved management of small-scale tropical cage culture' is concerned with identifying opportunities and constraints concerned with these issues, assisting the CARE-CAGES project and further focusing research to be of benefit to the rural resource poor.

One of the key issues in the failure of a research project to benefit the lives of the rural poor is connected to the absence of the intended beneficiaries from the research process. As it is working with an existing development project, R7100 has a rapid and targeted pathway for the dissemination of research findings and hence avoids this constraint. Non-governmental organisations (NGOs) can be considered to be the driving force behind the development of cage aquaculture in Bangladesh. Through CARE's CAGES project the capacity of smaller NGOs to develop and disseminate small-scale cage aquaculture technology has been strengthened. There exists a synergy in the relationship between CAGES and the regionally based NGOs. CAGES has strong technical staff and a training capability which, when coupled with the NGOs abilities to work with groups of rural households, creates a mechanism where cage aquaculture can be developed more quickly and information shared on a wider scale than if agencies were operating independently of one another. The partnership between a diverse range of organisations seems to be an effective one for developing and disseminating of aquaculture technology. The process is in marked contrast to past efforts that focused on developing cage aquaculture packages then disseminating them: a top down approach. The innovative approach adopted by CAGES works to the advantage of R7100 which can utilise the existing framework to identify research needs, conduct research and disseminate the results to those most in need. This is in contrast to traditional methods of communication between researchers and farmers that have tended to focus on a top down approach where research findings developed in isolation from intended beneficiaries are disseminated. Utilising this framework project R7100 conducted its research using two main approaches, on-farm trials and social surveys for each the benefits and constraints to the research process and the rural resource poor will be described.

#### **49 On – farm trials**

CAGES collaborates with local NGOs, in originally five, but now six, regions throughout Bangladesh Barisal, Comilla, Dhaka, Jessore and Syhlet and Natore. In each region NGOs were selected to collaborate on these trials, devised by R7100 in conjunction with TOs and NGOs. On-farm trials were then carried out by cage operators themselves in field situations, overseen by CAGES Technical Officers (TOs) and NGO staff. As trials were conducted by operators in field situations they

were intended to offer a more realistic assessment of the technical and economic validity of an option rather than being a piece of disassociated research. Trials initially encompassed a wide range of topics and from the assessment of their performance, key research topics were identified. As these trials were participatory in nature and funded by the CAGES the size of the trials was limited and generally consisted of a qualitative simple one or two cage assessment or an examination of the feasibility of an option rather than a quantitative assessment. The main topics addressed by such trials were the selection of local resources in cage culture such as seed, feed and cage materials and new techniques such as hapa breeding and nursing of postlarvae and fingerlings.

The benefits to the research process are in the participatory nature of the trials in which there is a realistic, assessment of the option. However the lack of quantitative data is a constraint to reporting due to the simple nature of the trial (lack of repetition; lack of true controls, etc), due to financial constraints and lack of experience by NGO staff and farmers. Ideally such trials would be complemented by benefited by research farm trials where replicates and different treatments can be examined. However the isolation of the trials from intended beneficiaries should be considered.

The benefits to the rural resource poor are already evident as materials such as Mritinga bamboo, originally examined by R7100, has been adopted by beneficiaries throughout Bangladesh. The simple qualitative problem of these trials is overcome by the collation and cataloguing of trials by CAGES staff. Using this catalogue, the performance of options can be reviewed by TOs and NGO staff. Through the strength of number of trials on similar topics an indication on the suitability of the option for adoption by the rural resource poor is derived. The capacity of the rural resource poor participating in these trials is also increased although if a trial fails this could lead to an unfavourable impression in those unfamiliar with cage culture.

## 50 Social surveys

To complement these essentially technical on-farm trials, the social context of small-scale cage culture was investigated in order to further focus and clarify research needs. Through social surveys the following three topics were examined:

1. The reasons for continuation and abandonment of cage culture
2. The role of gender in small-scale cage culture
3. The impact of cage culture on the community

**All three topics aimed to identify the constraints and opportunities raised by the implementation of cage culture by the rural resource poor and serve to identify strategies leading to its sustained adoption by targets, including women. Rapid Rural Appraisal was conducted in three villages selected by TOs in the regions CAGES operates. Included was one village where cage culture had been implemented relatively recently, (less than one year). To examine the role of gender and reasons for cage culture continuation and abandonment in each village three households were interviewed. The majority of data on gender issues were obtained via semi-structured interviews. Information was triangulated with key informants – in particular with staff from NGOs involved in the project and CARE-CAGES field staff.**

The interview followed a checklist of open-ended questions designed to gather qualitative data. In most cases, husbands and wives were interviewed separately. However in a number of instances, cultural restrictions meant that a wife could not be interviewed separately from her husband, even when the team of interviewers comprised a woman. To ensure consistency, the same interviewer and CARE Technical Officer carried out all interviews and notes were taken by another CARE staff member, acting only as an observer. To minimise the risk of intimidation to the villagers, no other persons were present during the interview.

To examine the impacts of cage culture meetings were pre-arranged with villagers and mapping exercises conducted. The use of communal resources and the impact cage culture had on these uses was then described. Of particular interest to project R7100 was the identification of conflicts of interest that would require further research in order to facilitate the adoption of cage culture by CAGES targets.

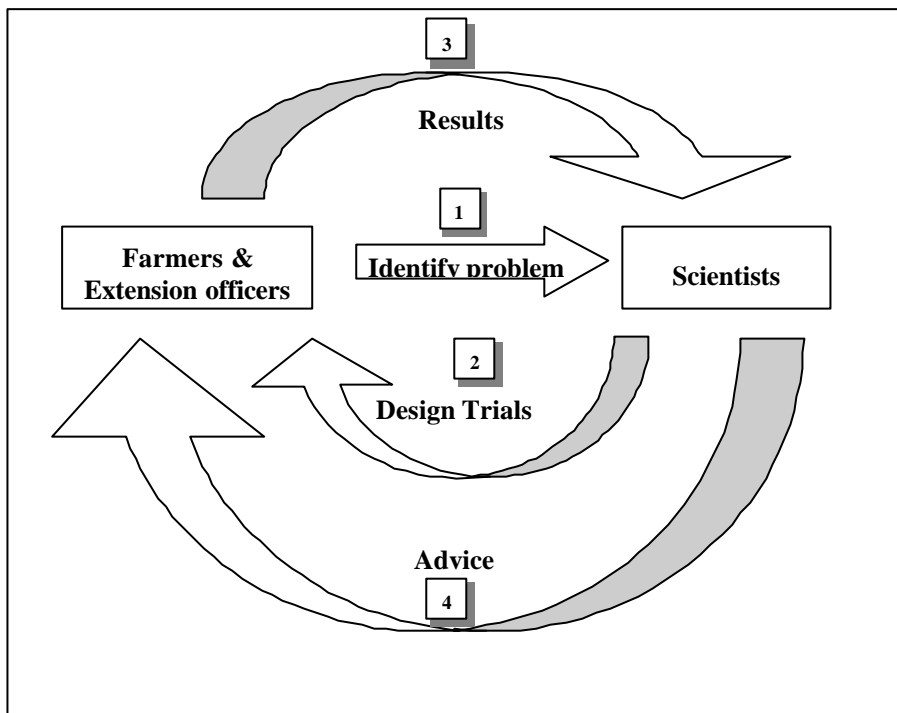
The surveys were vital to the research process identifying socio-economic opportunities and constraints on which further research could be based, such as the isopod disease constraint in Jessore region.

For the rural resource poor the benefits are derived from a combination of information disseminated to CAGES on the topics covered on which policies and development options can be based. Benefits also occur through the training of NGO and CAGES staff in social survey methodology enabling further research to be conducted outwith the lifetime of the research project. The findings of these further surveys can then be compared to the initial baseline.



## 50.1 The in-built institutional pathway

As reported R7100 works with an existing development project the CARE-CAGES project and hence has access to the in-built framework of working with Partner NGOs (PNGOs) to reach benefactors. Information is therefore exchanged between the research process and benefactors in a two-way manner to the mutual benefit of both groups and also the development project with which a synergy exists with the research process. Figure (1).



**Figure (1) The research framework of the Bangladesh component of Project R7100.**

Targets are therefore reached rapidly with disseminatory material such as the hapa-rearing pamphlet of which 10, 000 have been printed and are currently being disseminated.

## 51 Summary

The type of research conducted by R7100 can be described as demand-led, responding to the needs of the rural resource poor and women to which they have access through an existing development project and its institutional pathway. The benefits to the research process include identification of opportunities and constraints of interest to the farmers such as lower risk and hapa rearing technologies and disease constraints of which further research and training can be conducted. The mainly qualitative information gained using a combination of participatory methods can then be disseminated rapidly to benefactors.

The rural resource poor also benefit through a combination of awareness in cage culture brought about by village surveys and technical training by on-farm trials. The training and experience gained by NGO and CAGES staff by participation in these method will also continue to benefit the rural poor.

### **Appendix 3i. A Review of the Tools and Methodologies conducted by the Vietnam component of Project R7100.**

John Hambrey

The research process conducted by the Vietnam component of project R7100 differs in its approach from the Bangladesh project segment. Not only is research concentrated in larger marine systems but rather than research being demand led to the needs of the farmer participatory rural appraisal of the issues that face the rural resource poor in Vietnam was conducted. Examining whether the development of cage culture for poor farmers would address their livelihood needs. Unlike in Bangladesh it did not intervene in the current aquaculture or attempt to develop new technologies.

Utilising participatory rural appraisal techniques such as semi-structured questionnaires the following questions were addressed.

1. Development context
  - ?? Who would be the beneficiaries?
  - ?? To what resources did they have access?
  - ?? What was the potential for support from institutions?
  - ?? Seed
    - ?? What was the supply of seed?
    - ?? Was it sustainable?
2. Feed
  - ?? Was the supply of feed sustainable?
  - ?? Would increasing the use of trash fish for feed adversely affects the poor?
3. Technical/economic assessment
  - ?? Would grouper culture address the needs and aspirations of the beneficiaries as opposed to other income generating operations?
4. Market
  - ?? Was the market sustainable at a local, national or international level?

#### 51.1.1 The Research Process

The research process began with selection of potential beneficiaries from the poorest people of coastal villages, both those already involved in aquaculture and those not. After a rapid rural appraisal, participatory rural appraisal was carried out on the following lines Table (1).

Table (1) The methods utilised by the Vietnam component of R7100.

	Seed supply	Feed supply	institutional arrangement	Livelihoods	Economics	Markets
SSI with individuals	?	?	?	?	?	?
SSI with groups	?	?	?	?	?	?
Direct interviews	?	?				?
Diagrams	?	?	?	?	?	?
Field surveys	?	?				?
Association analysis	?					
Financial analysis	?			?	?	
Market analysis						?

From these methods it was found that whilst the development of grouper cage culture had arrested, lobster culture was expanding rapidly due to the higher potential returns and the demands of an international market. This gave rise to concerns as to whether these systems were both economically and environmentally sustainable.

The major source of feed for cage culture was found to be trash fish, which is part of secondary catches with no apparent human food market. However, there was found to be some overlap between the use of trash fish for cage culture and other uses, particularly pig feed and use by local people. Initially cage fish production was found to use 30% of available trash fish but this is now estimated at 60%. The supply of trash fish was recognised as a finite resource and whilst sustainable at present levels could become limited with further expansion of cage culture.

Stocking densities were currently low so there was little disease problem and environmental impact was limited, as profits were high there was no pressure to increase stocking density.

The researchers felt that they did not gain significantly more information from the participatory rural appraisal process, than they with utilising rapid rural appraisal, apart from developing their understanding through longer contact with the participants. However participants, the rural resource poor benefit from these exercises by developing their own capacity for assessing problems and opportunities.

## 52 Summary

Although different in its approach the tools utilised by the Vietnam component of R7100 benefits both the research process and the rural resource poor identifying opportunities and constraints through participatory rural appraisal. This not only identifies areas for further research projects such as the use of feed materials but also increases the awareness of seed and feed use, market selection and livelihood considerations amongst the rural resource poor.

#### **4. POLICY INITIATIVES FOR SUSTAINABLE CAGE CULTURE DEVELOPMENT**

*Chair*            John Hambrey

##### **Objective**

?? to develop an understanding of the role of policy in influencing the development of sustainable small-scale cage culture among the rural poor in the coastal marine and inland environments and to propose measures that may be considered at local and national policy levels.

##### **Output**

- ?? summary of key issues in cage aquaculture development in Asia;
- ?? summary of key issues in cage aquaculture in Vietnam and Bangladesh;
- ?? identification of key policies that may influence uptake and sustainability of cage culture by resource poor farmers in Bangladesh and Vietnam;
- ?? recommendations for future cage aquaculture development.

##### **Method**

- ?? presentation 1 – introduction to key constraints in cage culture in Asia (Malcolm Beveridge);
- ?? presentation 2 – review of cage aquaculture in Vietnam (John Hambrey)
- ?? presentation 3 – review of cage aquaculture in Bangladesh (Kenny McAndrew)
- ?? presentation 4 –critique(s) of cage aquaculture (open)
- ?? presentation 5 – summary presentation of key issues still to be addressed in Asia;
- ?? plenary discussion and formulation of guidelines.

### 53 Introduction

54 Although cage aquaculture is relatively new in Bangladesh and other countries in the Region it is generating considerable interest resulting in its rapid expansion throughout Asia. The expansion increases the likelihood of adverse environmental impacts. Appropriate policies require to be introduced and enforced to ensure that cage aquaculture remains a sustainable livelihood for the rural resource poor. Key issues in cage aquaculture development in Asia were identified and policy level recommendations to influence the sustainable development of cage culture among the resource poor were made.

#### **Key issues in cage aquaculture in Asia**

China, the Philippines and Indonesia can currently be considered as the biggest producers of caged fish within Asia and production continues to increase. The main reasons for expansion are that it is a relatively cheap and accessible income-generating activity, cages are easy to construct and provide a rapid return on investment. As the level of income flow increases operations can be quickly developed as operators build and stock extra cages. Cage aquaculture in Bangladesh is relatively novel, aquacultural activities having largely focused on pond and rice-fish systems such as *ghers*. Although there have been various attempts over the past twenty years to initiate cage aquaculture, it has only expanded significantly in the last three through the CARE CAGES project. There are currently approximately 5000 cages producing over 76 000 kg of fish in Bangladesh.

Expansion of cage aquaculture can create problems for both extensive and intensive types of production:

#### **Access to water bodies**

- ?? Social constraints, such as limited access afforded to some women due to cultural norms.
- ?? Power struggles between traditional users of the resource, including transportation and agriculture.
- ?? Tension between fish farmers and fishermen as cage culture impinges on traditional fishing grounds.

#### **Environmental issues**

- ?? Over-expansion in stationary water bodies may cause increasing waste organic matter with a high oxygen demand depleting oxygen levels and resulting in fish death, as has been illustrated by cage culture in the Philippines, Indonesia and China.
- ?? Marine sediments can become polluted with excess feed, especially in sheltered areas, impacting negatively not only on cage culture but other resource users.
- ?? The use of non-indigenous species can impact on indigenous fish species.

**With the development of cage culture therefore, there may be a need for regulation, both to maintain the feasibility of access to cage culture for the resource poor and to keep production**

**levels within environmental capacity. With the increasing intensification and production levels, however, the question of how to develop sustainable cage culture also needs to be addressed.**



*Key issues in cage aquaculture in Vietnam*

Marine cage culture has a huge potential for production and for income generation for poor farmers in Vietnam. Here the key issues are:

*Access to water bodies*

?? This is not a major problem although there are sometimes local difficulties.

**54.1.1.1 Access to inputs**

?? **There is currently insufficient seed to maintain expansion. Development of hatcheries needs to be encouraged by government institutions, NGO and donors.**

?? Current feed sources (i.e. trash fish) are finite. Prices may increase, jeopardising the financial viability of the industry. New feed sources need to be identified.

?? Finance is available but needs to be better linked to aquaculture development.

**54.1.1.2 Capacity**

?? The poorest are the last to benefit from training, information and extension services. Extension services and information materials need to be improved and made available to poor farmers.

**54.1.1.3 Management and regulation**

?? The formulation of the correct management regimes regarding cage culture at various levels are the most important strategies to implement before the expected expansion of cage culture in Asia occurs. Such examples include the national monitoring of disease outbreaks and local regulation of pollution..

?? Prices for lobster and grouper are currently high but the market is limited. Therefore management should address issues such as marketing, perhaps identifying new species for production, new markets and the reduction of production coasts. However the latter point may adversely affect poor farmers operating and relying upon single cages and therefore not benefiting from economies of scale.

?? The expansion of cage culture will therefore require regulation to protect water quality, prevent destructive disease outbreaks, maintain bio-diversity and to maintain and expand markets to prevent the oversupplying of markets.

### ***Key issues in cage aquaculture in Bangladesh***

The CAGES project currently involves approximately 400 households operating 5000 cages, often in remote areas. Working through partner NGOs means direct contact with participants. The project is poverty focused: 33% of participants are considered landless and 58% of all participants are women who are able to incorporate cage culture with their daily routine and establish sites close to the homestead. Key issues are:

#### *Access*

?? This issue is becoming increasingly important. In some cases access initially available from landlords was later withdrawn. In theory there is free legal access to public water bodies but in reality access is often controlled by powerful local interests. The use of local NGOs can help alleviate these constraints.

#### *Finance*

?? The start-up costs are low - generally about \$10 to construct and stock a cage - with credit generally available through local NGOs or money lenders. Credit however may not be available to the very poorest groups, although they can become involved in activities such as feed preparation, guarding and net making.

#### *Seed*

?? Many hatcheries exist within Bangladesh both private and government. However there are few nurseries, so access to fingerlings can be limited. Expansion of nurseries needs to be encouraged.

#### *Feed*

?? The CAGES project recently removed the subsidies it issued for feed costs and as a consequence the types of ingredients are now diversifying as operators integrate cage culture into other household activities utilising items such as vegetable and kitchen waste and there has been interest in vermiculture to produce worms as suitable feed items.

#### **54.1.1.4 Cage materials**

?? The costs of construction have recently been reduced by the implementation of cages made from locally available bamboo.

#### **Environment**

?? Small-scale cage culture is a low input method of fish production and as the water bodies are not utilised all year round so benthic degradation is not thought to be a problem and there have been minimal disease incidents. However, intensification of production methods has been seen in other countries as farmers gain confidence and as cash flow increases. It is recommended that the situation be kept under review. There is also concern about the issue of escaped fish. However, cage culture utilises the same non-indigenous species as pond culture and as ponds flood may be a more secure system. Cage culture of more invasive, competitive top predators should be discouraged.

**Marketing**

?? Live fish can increase the price of the product by 20–30% and should be encouraged.

There is increasing evidence that secondary adoption by richer farmers who have observed the success of project participants is occurring, which needs to be assessed and monitored. The guiding principle must be to try to ensure that cage culture is a sustainable activity for poor farmers.

***Identification of key policies to influence the uptake and sustainability of cage culture by resource poor farmers in Bangladesh and Vietnam.***

- ?? *As mentioned in section 3, the key to influencing the uptake and sustainability of cage culture in Asia by the rural resource poor is to adopt policies that encourage stronger and more extensive linkages between farmers and research and local and national development institutes and government departments via increasing awareness of cage culture. Through its linkages to, and collaboration with, a development project and regional NGOs, Project R7100 has demonstrated that it is both possible and of benefit to the rural poor.*
- ?? **Such links with development agencies could influence policies with local and national NGOs, providing access to micro-credit and thus removing financial constraints and improving financial management through training. These NGOs are also involved in other IGAs such as fingerling production and wild fry collection. Hence, integrating cage culture with their existing framework would be of immense benefit, reducing input constraints. The monitoring of cage culture impact could also be facilitated through these links at the local and regional level through the use of local discussion forums.**
- ?? **Links and collaboration with government departments are vital in influencing decisions at government level. Proposed policies included the allocation or zonation of waterbodies by government to cage culture practises for the rural resource poor. While an Integrated Coastal/Inland Water-body Management approach is recognised as the best approach to addressing such issues, it is recognised as impractical in many contexts, given the extent and degree of pressure on resources and the lack of skills and finance. Although research is required prior to establishing guidelines for cage culture development, somewhere between 1 and 5% of the surface of a water-body was proposed as probably being sufficient to prevent adverse environmental impacts and conflicts with other resource users. While it was recognised that catching of wild fry**

Recommendations for future cage aquaculture development

**?? From a review of these key issues members of government and university institutions, NGO and development organisations and R7100 researchers produced the following recommendations.**

- ?? Environmental degradation of permanent water-bodies and coastal areas must be given consideration. Environmental conditions can be monitored by observation of the water and benthos using methods as simple as a Secchi disk to monitor turbidity of the water column or smell and visual tests of benthic muds to examine for the presence of hydrogen sulphide (H<sub>2</sub>S) or anaerobic conditions. In inland seasonal waterbodies this problem is alleviated in the dry season when the benthic muds are allowed to recover. In permanent water-bodies or in coastal areas farmers should be encouraged to periodically move their cages to allow areas to recover.
- ?? Alternate feed sources such as kitchen waste, agricultural by products, earthworms or under-utilised by-catch should be considered and promoted to reduce costs and environmental impacts of cage culture.
- ?? **Concerning the use of non-indigenous species, cage aquaculture must not only operate within any legislative framework currently in place (for example, by not rearing tilapia in Kaptai lake, Bangladesh) but also try to influence policies through dialogue with government departments. Tilapia are an appropriate species for cage culture by the rural poor and their use should be considered as they offer a good return on a low investment especially in the absence of other species and where they are currently used in other systems such as ponds. However, there remain concerns in some areas about their impacts on indigenous fish communities and on fisheries.**
- ?? **The use of indigenous hatchery reared species to alleviate the pressure on wild caught fry should be considered whenever possible, although it is recognised that this requires training in hatchery and nursing skills. These initiatives however can only occur through greater co-ordination between government and NGO sectors.**
- ?? **Greater exchange of information and collaboration between regional and national development projects and the NGO sector is essential to ensure maximum positive and minimum negative impacts from the implementation of cage culture. This could be facilitated through regional or national forums on aquaculture where cage culture practises and legislation are on the agenda.**

## 5. DISCUSSION

From the combination of group and plenary discussions many points of interest have been raised regarding the appropriate use of small-scale cage culture as a mechanism to reduce the poverty of the rural resource poor. Participatory approaches were seen to have been of benefit the research process and the rural resource poor

Guidelines for the production of low-input, low-output cage culture extension and training materials have been identified. Key to this is a participatory approach to research with existing institutions utilising in-built pathways for the identification of research topics and dissemination of research findings. To increase the quality of the outputs and to add value to the research process a greater degree of linkage should be sought as this increases both the amount of knowledge available and number of beneficiaries reached. The level of linkage is also critical in attempting to affect policies concerning small-scale cage culture at the NGO development or government level.

Guidelines for planners, policy makers, and development specialists, to assess potential for low-input low-output cage culture within social economic and institutional environment, and improve selection of technological options have been produced. These take the form of a checklist for aquaculture potential, cage culture profiles and decision trees serving as a basis of discussion between farmers and extension workers. These are not a definitive guide covering all small-scale cage culture in Asia but rather serve as a basis for discussion that can be used to generate guidelines which can be adapted to particular regions, situations and individuals. The process allows decisions to be made on whether cage culture is appropriate or not and to choose the most appropriate system.

54.1.2 Appendix 6. The timetable for Project R7100 workshop

	<b>Sun 9<sup>th</sup> July</b>	<b>Mon 10<sup>th</sup> July</b>	<b>Tues 11<sup>th</sup> July</b>
<b>8-9</b>	Agreement on Agenda and approach  Introduction to Session 1: Assessment of cage aquaculture potential	Introduction to <i>Session 2</i> : Development options for cage culture potential  <i>Session 2</i> : parallel groups on generic profiles (inland/marine) and decision trees	Introduction to <i>Session 4</i> Policy issues in cage culture  <i>Session 4</i> : presentation 1 (introduction; MB)  <i>Session 4</i> : presentation 2 (Vietnam; JH)
<b>9-10</b>	<i>Session 1</i> : parallel groups on checklist	<i>Session 2</i> : parallel groups on generic profiles (inland/marine) and decision trees	<i>Session 4</i> : presentation 3 (Bangladesh; KM/MB)  <i>Session 4</i> : presentation 2 (Key issues; KM/MB)  <i>Session 4</i> : any other presentation
<b>10-11</b>	55 Coffee  <i>Session 1</i> : checklist discussion	<b>Coffee</b>  <i>Session 2</i> : parallel groups on generic profiles (inland/marine) and decision trees	56 Coffee  <i>Session 4</i> : Identification of key issues
<b>11-12</b>	<i>Session 1</i> : parallel groups on checklist  <i>Session 1</i> : checklist discussion	<i>Session 2</i> : discussion of generic profiles (inland/marine) and decision trees	<i>Session 5</i> : OPEN DISCUSSION
<b>12-1</b>	<b>LUNCH</b>	<b>LUNCH</b>	<b>LUNCH</b>  <b>FIN</b>
<b>1-2</b>	Afternoon cage visit        Approx 4 hours	Introduction to <i>Session 3</i> : Development and communication techniques  <i>Session 3</i> : Presentation 1 (Bangladesh PB)	
<b>2-3</b>		<b>56.1 Tea</b>  <b>Session 3: Presentation 2 (Vietnam (Tuan/Thuong))</b>  <i>Session 3</i> : Discussion and Recommendations	
<b>3-4</b>		<i>Session 3</i> : Discussion and recommendations	
<b>4-5</b>			

**Appendix 6i. List of Delegates Attending Project R7100 workshop**

<b>Forename</b>	<b>Surname</b>	<b>Designation</b>	<b>Institution</b>
Syed	Arifuzzaman	APO	CAGES Dhaka
Dr Gias Uddin	Ahmed	Professor	FF BAU Mymensingh
Dr Khan Kamaluddin	Ahmed	Senior Scientific Officer,	BFRI Rangamati
Asma Akhter(Munni)	Akhter	APO	CAGES Comilla
Naseem Ahmed	Aleem	APC	CARE-CAGES
Wadud	Ali	APO CAGES	CARE-Barisal
Md. Barkot (Bokul)	Ali	Director	DJKS Dulai Pabna
Md. Abdul	Alim	TO (Aqua) GOLDA Jessore	CARE Khulna
Md. Golam Rasul	Arman	Secretary	VDDC
Md. Ebadur Rohman	Badal	Executive Director	RAC Bangladesh
Shyamal Kanti	Barman	TO (T&E)	CAGES Jessore
Taslina	Begum	TO	CAGES Dhaka
Malcolm	Beveridge	Stirling University	Stirling Scotland
S M Ishaque	Bhuiyan	DFO Barisal	DOF Barisal
Paul	Bulcock	Stirling University	Stirling Scotland
Didarul Anam	Chowdhury	Technical Co-ordinator	CARE-Bangladesh
Sukanta	Chakma	Program Co-ordinator	Green Hill
Sonatan	Chakma	Co-ordinator	Green Hill
Bibhash	Chakraborty	TO (T&E)	CAGES Rangamati
Gopal	Datta	TO (Aqua)	CARE- GOLDA
Tarun Kumar	Ghosh	TA Jessore	CARE-CAGES
John	Hambrey	Nautilus Consultants	Edinburgh, UK
Anwar	Hossain	TA Barisal	CARE-CAGES
Zakir	Hossain	TO	CAGES Barisal
Md. Robiul Awal	Hossain	Scientific Officer	BFRI RS Chandpur
Dr. Rezaul	Hasan	Professor	BAU, Mymensingh
Rezaul	Haque	TO (M&D)	CAGES CBHQ
Sk Md. Ziaul	Huque	PDO (PTD)	CARE-CAGES
Md. Rafiqul	Islam	TO	CARE-CAGES
Faruqul	Islam	Co-ordinator	ITDG-Bangladesh
Nurul	Kabir	TO	CAGES Comilla
Gazi Md.	Kashif	AA	CARE-CAGES
Moksada	Khanam	AA CAGES	CARE-CAGES
Md. Abdul	Latif	APO	CAGES Natore
Md. A. Goffar	Mondol	APO (PTD) CARE Jessore	CARE-CAGES
Kenny	McAndrew	CAGES PC	CARE-Bangladesh
Nurun	Nahar	TO (Trg)	CARE-CAGES
Khairul Bashar	Mian	TA Comilla	CARE-CAGES
Dr.	Rahmatullah	Professor	BAU, Mymensingh
Alamgir	Rahman	PDO (Trg)	CARE-CAGES
Anisur	Rahman	AO (Fin)	CAGES CBHQ
Md. Abdur	Razzaque	TO (T&E)	CAGES Jessore
Jules	Sparrey	Reporter	
Ta Khak	Thoung	University of Fisheries	Nha Trang Vietnam
Le Anh	Tuan	University of Fisheries	Nha Trang Vietnam
Dr. Abdul	Wahab	Professor	BAU, Mymensing





*References*

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