THREE YEAR POST-TSUNAMI REHABILITATION OF FISH CAGE CULTURE ON THE ANDAMAN COAST OF THAILAND: THE CURRENT STATUS AND THE NEED FOR FUTURE SUPPORT

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ABSTRACT

The Indian Ocean tsunami of 26 December 2004 severely affected six provinces (Ranong,Phang-nga, Phuket, Krabi, Trang and Satun) on the Andaman Sea coast of Thailand. About 27,000 fish cage culture operators in the Andaman coastline were affected by the tsunami impact, covering a total cage area of some 1,123,176 square meters. Estimate of the losses from aquaculture cages was approximately US$92 million. The compensation allowable would be 20,000 baht for cage farms registered with the Departmernt of Fisheries (DoF) and 14,000 baht for cage farms not registered with the DoF. Based on the survey conducted, the money compensated subsequently used to buy materials for cage re-construction and cage repairable accounted for 28.1% of the total, and to buy seed, feed and chemical for culture operation 15.8%. A surprising finding is that 56.1% of compensated money was used for other purposes. The cage farmers raising the grouper, sea bass, red snapper, cobia, green mussel, oyster and lobster accounted for 37.7%, 35%, 11.8%, 10.1%, 4.4%, 0.7% and 0.3% of the total number of cage farmers, respectively. The seed shortage, high cost of trash fish, disease outbreak and marketing were problems and constraints encountered. Technical, marketing and financial supports are required for the future.
Keywords: post-tsunami, cage culture, rehabilitation

INTRODUCTION

Cage culture sites on the west coast of Thailand are typically located in the mouths of estuaries and seaward parts of delta and mangrove areas. These areas were exposed to the rapid rising waters and wave of the tsunami and their typically fragile construction resulted in the breakup of some of the cages and loss or escape of the stocks. Losses or damage claims eligible for government compensation is registered at the provincial fishery office. The compensation package for cage farms is rather low compared to the price of the cage and value of the stock. Responses by various assisting agencies and NGOs were forthcoming, but they could not assist recovery for all of the owners affected. Some fish cage culture operators were able to rehabilitate by themselves, but there were many owners affected who require technical support for better management. This investigation detailed in the present paper seeks to highlight the current status of fish cage culture on the Andaman coast of Thailand after three years post-tsunami rehabilitation and the needs for future support.

MATERIALS AND METHODS

Study area

The cage culture farms are located along the coast of the Andaman Sea in Ranong, Phang-nga, Krabi, Trang and Satun provinces as sites for the study.

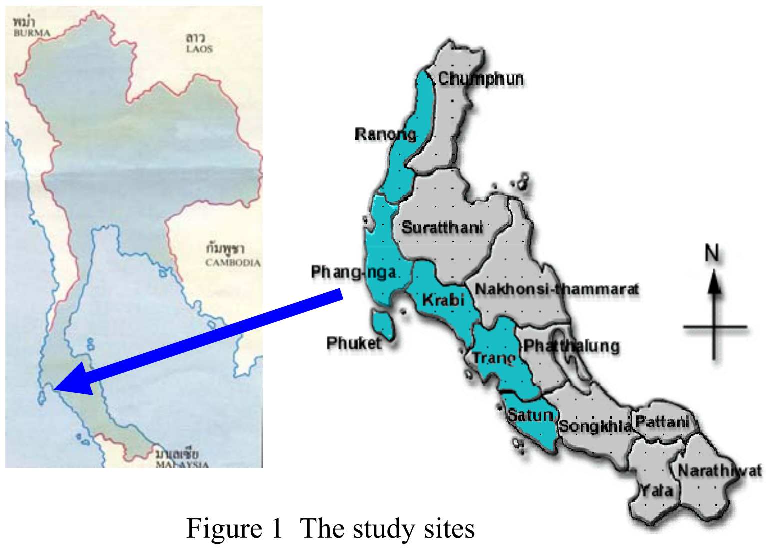

Figure 1 The study sites

General Socio-economic Data Collection

A rapid appraisal methodology was adopted for the overview at the provincial level. Semi-structured interviews were the principle method of data collection used. Interviews were conducted using a topic check-list. They were not constrained by the used of a structured survey, but rather flexible and open to exploring new issues and topics as they arose. Interviews were carried out in 9 villages from 5 provinces on the coast of Andaman sea. A total of 10 interviews were conducted between April – June 2008 on cage farms. Following the collection of information in qualitative study, a survey questionnaire was developed to collect a wide range of quantitative data from the farmers at the household level in each of the cage culture areas. Information was gathered regarding the production, farm economic, farm management practice and problems experienced by the cage culture farmers. The aim was therefore to gain a broad understanding of the cage culture activities of each culture area and the financial situation of respondents after the tsunami and its damage.

Environmental Data Collection

The water samples from 7 cage farms located along the coast of the Andaman Sea in Ranong, Phang-nga, Krabi, Trang and Satun provinces were collected to analyze the water qualities. Water temperature, DO (dissolved oxygen) concentrations were measured in situ using a YSI oxygenmeter. Samples were kept on ice and analyzed soon upon return to the laboratory. Before determination of ammonia-N, nitrite, nitrate and phosphate concentrations, samples were filtered through pre-washed GF/C filters. Ammonia-N of water samples was analyzed by the phenolhypochlorite method (Solorzano, 1969). Nitrite of water samples was analyzed by the diazotization method (Strickland and Persons, 1972). Nitrate was analyzed by the cadmium reduction (Strickland and Persons, 1972). The nitrate in water samples was reduced to nitrite and the original nitrite and nitrite from reduction were analyzed using the same diazotization methods (Strickland and Persons, 1972). The filtrable reactive phosphate was analyzed by the ascorbic acid method (Strickland and Persons, 1972). Chlorophyll *a*, the coliform bacteria and fecal bacteria in sea water were analyzed by the standard method for the examination of water and wastewater (APHA, 1980).

RESULTS AND DISCUSSION

Current Status

The compensation allowable would be 20,000 baht for a cage farm registered with the DoF and 14,000 baht for a cage farm not registered with the DoF. The compensation package for cage farms is rather low compared to the price of the cage and value of the stock. However, the Thai government provided the budget through the DoF of over 111.6 million bahts to restore the cage farms on the coast of Andaman sea after the tsunami (DoF, 2005). Excluded here are funds from the private sector, NGOs and philanthropic foundations. There were several types of patrons from those organizations for the cage farmers, including provision of cash funds, materials for cage re-construction and fish seed. Based on the survey, the money compensated used to buy materials for cage re-construction and cage repair accounted for 28.1%; to buy seed, feed and chemicals for culture operation it accounted for 15.8%. It is a surprising finding that 56.1% of compensated money was used for other purposes, as shown in Figure 2.

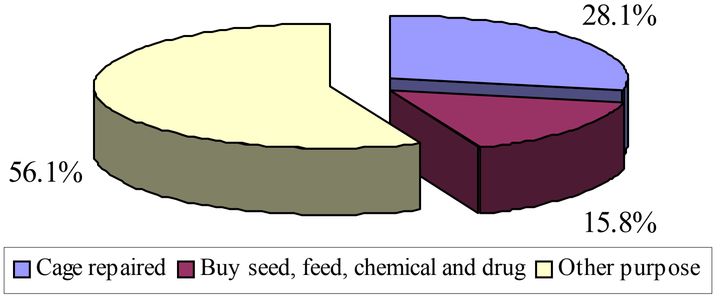

Figure 2 The purpose of compensated money as utilized by the cage farmers on the coast of Andaman Sea .

Cage Culture of Fish -- The cage farmers raising the grouper accounted for 37.7%. Three species of grouper were encountered most frequently during the study, including Red spot grouper, 'Dork daeng' *Epinephalus coioides,* Black spot grouper, 'Dork dam' *E. malabaricus* and Duskytail grouper Orange spot 'Dork maak' *E. bleeker*. *E. coioides* is the most common cultured species of grouper on the Andaman coast of Thailand. *E. bleeker* was raised by some farmers, but it grew slowly and did not fetch a high price when compared to *E. coioides* and *E. malabaricus.* The farmers raising seabass (*Lates calcifera*) accounted for 35%, since seabass fry are readily available from private and government hatcheries. However, seabass culture generated a lower profit than grouper culture. Seabass also required more feed, according to the farmers interviewed. Some farmers in Ranong, Phang-nga and Krabi also raised seabass in separate cages from grouper. Seabass culture alongside grouper culture appeared to provide a more secure basis than grouper alone, as seabass could be sold in the local market for cash when required. Farmers stocked red snapper (*Lusjanus argentimaculatus*) as a lower investment alternative to grouper and seabass. The profit generated by red snapper culture was lower than grouper. However, grouper culture was found to be particularly limited in some areas of Phang-nga and Ranong provinces where the culture environment is not suitable for grouper culture due to low salinity during rainy season. Red snapper appear to be more tolerant in freshwater and subject to fluctuations under certain environmental conditions, and are therefore a lower risk alternative to farmers in those provinces. Cobia (*Rachycentrum canadum*) is one of alternative species for the farmers in Krabi province. The cage farmers raising the red snapper and cobia accounted for 11.8 and 10.1%, respectively. (Figure 3)

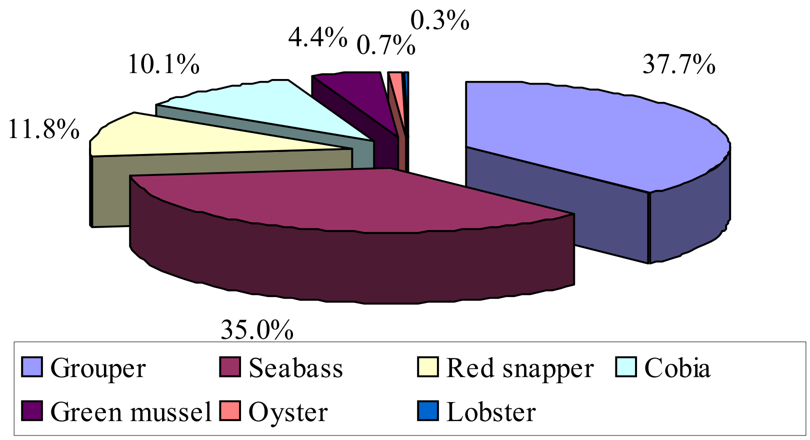

Figure 3 The typical culture species in cage farms on the Andaman coast of Thailand, based on survey data.

Mussel Culture – Mussel rafts have been successfully operated in Klong Naka, Suksumran district, Ranong province, for a number of years. The typical mussel raft is approximately 9 -15 m x 18 - 20 m, constructed of wood and styrofoam with the mussels growing on dropper ropes. Mussel seed is obtained from other locations in Thailand and the crop is marketed outside of the area.

Current Problems and Constraints

Culture Operation

The main operation constraints for the cage farmers were the high cost and shortage of seeds. Seed stock can be obtained by fishing or can be purchased. The current seed supply is problematic because the trend of seed catching in the wild has been gradually reduced over recent years. However, there is only a limited supply of grouper seed for cage culture, and much current grouper cage culture is still based on the supply of wild grouper seed. To meet the demand, alternative sources of supply had to be found from other provinces and the seed availability determined. As a consequence, the price of grouper seed increased 3-4fold over the last few years. The seeds bought at a distance from farms were also subject to transportational stress. This resulted in a higher mortality rate. The grouper and snapper hatchery technique was not much developed. The production of sea bass fry from the DoF hatcheries met the demand because the technique of nursing the fry was highly developed. Another factor causing the increase in cost of production was the increase in the price of feed. The high cost of trash fish that is used as feed for the grouper, red snapper and cobia cage cultured is one constraint. Any increase in the cost of the trash fish would significantly affect the cost of production. Cost of trash fish is the single most expensive item in the cost of production, comprising more than 40 %. Typically, trash fish from the fishing operation are used as the feed source although in times of low catch, trash fish may be purchased for use as feed. There was pellet feed available only for sea bass, but not available for grouper, red snapper and cobia cage culture.

The problem of diseases was experienced by all cage culturists. Not all the diseases were identified and the infected fish treated. For example, the cause and treatment of air bladder disease was not known. Fish disease and mortality were the most common reported problems associated with cage culture. In sea bass, Columnaris disease caused by *Flexibacter columnaris* is one of the diseases commonly found in juveniles which are raised in water of low salinity during rainy and winter seasons as well as during the period October to November each year. Lymphocystis disease is commonly found in seabass raised in cages, especially among juveniles 4–7 cm in total length. *Trichodina* also causes problems to seabass in cages. The species attach themselves to the gills of seabass. More than half of juvenile seabass heavily infected with this parasite died. For grouper, two viruses have been identified with major problems at the fry and fingerling stage of grouper culture in southern Thailand. The first virus was identified in diseased grouper exhibiting paralytic syndrome. The affected fish exhibited dark coloration, anorexia, loss of equilibrium and corkscrew-like swimming motion and suffered very high mortalities. (Danayadol *et al*., 1995). The second virus was isolated from diseased grouper exhibiting lethargy, dark coloration of the tail and fins and loss of balance. The virus was partially characterised as an iridovirus. This virus has been confirmed as the etiological agent of the disease by experimental infection (Kasornchandra and Khongpradit, 1996).

Marketing

The cage farmers in general were faced with fluctuating market situations. With an increasing number of cage culturists and rising demand for live fish, an excess in supply over demand developed. Marketing of live sea bass and grouper was also seriously affected. The local farmers find it very difficult to compete with the prices set by the middlemen. The marketing problem appeared in Cobia culture when fish reached marketable size.

Preliminary Economic Analyses

Cage Culture of Fish. The typical fish cage is 3 m x 3m x 2m deep, usually grouped in an array of 10-30 cages. Each array has a platform topped with a simple hut for the caretaker. Middlemen purchase the fish at the cages for transport to markets outside the area. Grouper and seabass are more expensive than most other fish species. The demand is therefore rather limited. The supply for the local market is already adequate and the prospect for markets abroad is being developed by local producers. For seabass, the demand for specific processed types and various sizes of marketable fish will also influence the expansion of the industry and its foreign market. At present, seabass is usually sold in the local markets. The product is also exported to neighboring countries. For grouper, the live product is exported principally to Hong Kong by air. Table 1 presents a summary of the capital costs, operating parameters, and a summary budget for cage culture.

Mussels. Technological requirements for mussel culture are rather low; rafts require minimal labor; on-site security is not essential; more than one household can work on a single raft; and there is a history of mussel culture in Klong Naka, Ranong province. Based on figures obtained from several sources, a typical summary budget for a raft is presented in Table 2. In addition to the concern about carrying mentioned previously, there appears to be little guidance and information available to the farmers regarding ecologically sound site selection, construction and operation. The DoF has indicated that they are willing to provide training in mussel culture. At present, the number of rafts in the Klong Naka is greatly reduced, as most of them were located near the mouth and were destroyed by the tsunami. The current survival rates of mussels are reportedly to be much lower than before due to being eaten by Puffer fish.

Table 1. Summary of average capital costs, operating parameters and annual budget for one fish cage.

Items	Grouper	Sea bass	Red snapper	Cobia
Cage dimension (m)	3 x 3 x 2	3 x 3 x 2	3 x 3 x 2	3 x 3 x 2
Capital cost of cage and shelter (in Thai baht)	10,367	10,000	9,841	12,709
Life expectancy (Years)	3	3	3	5
Depreciation per cage & shelter (baht per year)	3,456	3,333	3,280	2,542
Operating parameters				
Culture period (months)	12	8	7	12
Seed cost (baht/fish)	20	20	40	90
Size at stock (inches)	3-5	4-5	4-5	8-10
Stocking rate (fish/cage/crop)	400	315	108	40
Size at harvest (kg.)	0.8-1.2	1.0-1.2	1.0-1.2	5-8
Survival (%)	85	65	80	90
Total weight produced (kg/cage/crop)	138	123	103	270
Reported feed usage rate (kg/cage/day)	3.04	4	4	5
Total feed used per crop (kg/cage)	420	492	360	900
Feed cost (baht/kg)	10	10	10	10
Number harvested (fish/cage)	340	205	86	36
Annual budget				
Sales price (baht/fish)	260	110	130	65
Total revenue (baht)	35,880	22,550	13,390	17,550
Seed cost (baht)	8,000	6,300	4,320	3,600
Feed cost (baht)	4,200	4,920	3,600	9,000
Gross return per cage (baht)	20,224	7,997	2,190	2,408

Table 2. Summary of annual budget for one mussel raft.

Capital cost per raft (baht)	13,250
Average life (Years)	3
Depreciation (baht/year)	4,417
Crops per year	1
Operating cost (baht/crop)	17,465
Gross sale per crop (Baht)	21,240
Gross return to capital and labor (baht/year/raft)	-642

Water Quality Monitoring

Mean salinity, pH, water temperature, dissolved oxygen, and total suspended solids did not differ during the various study periods. The highest salinity values were found during the dry season (April-May) and the lowest salinity values were observed during rainy season (June-September). The slight reduction in salinity level came towards the end of the year. It is clear that the seasonal variation affects water salinity level as a result of the rainfall (Wijesekera et al.,1999). Water pH values measured in the cage farms at all stations in this study were shown to be in the range of normal seawater pH. Normal seawater pH is limited to the range 7.5 to 8.4 (Zeebe and Wolf-Gladrow, 2001). Mean water temperatures in the study areas are summarized in Table 3. The seasonal variation affects water temperature level. The resulting values of dissolved oxygen (DO) from this study were normalized and higher than environmental criteria as recommended by the Pollution Control Department (1994). This result is very difficult to correlate with cage culture activities, because DO in sea water is affected by various factors, including temperature (Pilson, 1998). It is well documented that DO in the water column is one of most important factors for maintaining life in marine organisms. Total suspended solids concentrations are reported in Table 3. From observation, high water turbulence occurred during the northeast monsoon season, rendering high water turbid in the cage farms.

In the present study, the variation of nutrient concentrations did not differ among the various study periods (Table 3). Nutrient concentrations in the study areas fluctuated throughout the study periods. The increasing levels of nutrients in the sampling area might be attributed to the fact that many cage culture farms were in operation. Besides the accumulation of fish excretion from the cages, the farmers provided excessive trash fish as feed, which further contributed to the accumulation of organic matter in the area. Mean concentrations of total inorganic nitrogen (TIN = NO^{-2} + NO^{-3} + NH^{+3}) and orthophosphate (PO_4^{-2}) are given in Table 3. The concentrations of NO^{-2}, NO^{-3}, NH^{+3} and PO_4^{-2} are in an acceptable range recommended by the Pollution Control Department (1994).

Chlorophyll *a* concentrations were fluctuated throughout the study periods and rather low during the rainy season when there was heavy rainfall and a reduction in solar radiation. However, chlorophyll *a* concentrations did not differ during the study periods. The high levels of chlorophyll *a* in the study area are probably the result of availability of nutrients such as inorganic phosphorus and nitrogen.

Bacteriological Monitoring

In the bacteriological study, the highest value of total coliform bacteria and fecal coliform bacteria were found in sampling stations at Ban Ba Gan in the 1st study period (Table 4-5). The content in MPN/100 ml was higher than 1,600; this value was higher than the value recommended by the Pollution Control Department (1994). This indicated the presence of contamination from domestic waste in cage farms. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with human or other animal fecal material. The values of total coliform bacteria and fecal coliform bacteria were found principally in cage farms, but a low value was found at the most stations in different sampling periods, and these values were not higher than the value recommended by the Pollution Control Department (1994), except in the 1st and 2nd study periods at Ban Ba Gan, Krabi province.

Table 3 Mean environmental quality parameters of surface water in cage farms located on the Andaman coast of Thailand from May 2007-April 2008.

Province	Study sites	Water quality parameters (Mean±SD)				
		Salinity (ppt)	pH	Water temp. (C^o)	DO. (mg/l)	TSS. (mg/l)
Ranong	Ban Klong Naka	24.41±4.52	7.42±0.16	28.43±0.71	7.32±0.79	22.85±2.40
Phang-nga	Ban Kuraburi	23.61±3.05	7.67±0.23	28.66±0.70	6.51±0.56	24.58±7.78
	Ban Num Khem	23.75±5.11	7.64±0.16	28.60±0.83	6.60±0.76	37.79±25.09
	Ban Thung Ma Phow	20.33±5.24	7.28±0.28	29.63±0.79	6.69±0.90	16.88±2.21
Krabi	Ban Ba Gan	23.69±3.77	7.49±0.15	28.78±0.69	5.65±1.33	32.61±20.43
	Ban Tha Ma Phow	26.13±3.58	7.28±0.20	28.99±0.61	5.50±1.11	26.77±13.20
Trang	Ban Yong Sa Tar	16.1±6.50	6.91±0.13	28.68±0.60	5.44±1.39	22.57±7.97
Satun	Ban Ba Kan Kai	24.79±2.86	7.66±0.33	30.2±1.43	6.82±0.77	28.98±10.15

Table 3 Continued

Province	Study sites	Water quality parameters (Mean±SD)				
		NH^{+3} (mg/l)	NO^{-2} (mg/l)	NO^{-3} (mg/l)	PO_4^{-2} (mg/l)	Chlo *a* (mg/l)
Ranong	Ban Klong Naka	0.111±0.011	0.021±0.003	0.028±0.006	0.019±0.014	2.89±0.45
Phang-nga	Ban Kuraburi	0.117±0.012	0.019±0.002	0.035±0.012	0.011±0.002	1.43±0.66
	Ban Num Khem	0.114±0.011	0.019±0.003	0.050±0.021	0.013±0.003	2.25±1.10
	Ban Thung Ma Phow	0.119±0.012	0.022±0.001	0.051±0.009	0.014±0.005	1.84±0.52
Krabi	Ban Ba Gan	0.178±0.041	0.028±0.007	0.106±0.047	0.057±0.049	3.18±1.32
	Ban Tha Ma Phow	0.176±0.048	0.099±0.259	0.180±0.307	0.021±0.017	5.54±2.43
Trang	Ban Yong Sa Tar	0.141±0.031	0.019±0.012	0.100±0.065	0.011±0.001	0.91±0.36
Satun	Ban Ba Kan Kai	0.151±0.022	0.026±0.009	0.058±0.020	0.013±0.009	4.85±2.23

Table 4. Range of total coliform bacteria in surface water of cage farms during different sampling periods.

Province	Study sites	Total coliform bacteria (MPN/100 mL)			
		1st	2nd	3rd	4th
Ranong	Ban Klong Naka	17-170	2-22	2-9	2-7
Phang-nga	Ban Kuraburi	12-50	2-220	7-170	9-150
	Ban Num Khem	5-34	5-27	34-170	12-130
	Ban Thung Ma Phow	140-500	7-9	0-2	0-6
Krabi	Ban Ba Gan	34-1600	80->1,600	17-500	23-900
	Ban Tha Phow	27-170	17-170	11-34	14-50
Trang	Ban Yong Sa Tar	110-150	8-22	7-11	7-19
Satun	Ban Ba Kan Kai	6-12	8-500	2-7	0-2

Table 5. Range of total fecal coliform bacteria in surface water of cage farms during different sampling periods.

Province	Study sites	Total fecal coliform bacteria (MPN/100 mL)			
		1st	2nd	3rd	4th
Ranong	Ban Klong Naka	0-34	0-7	0-2	0-2
Phang-nga	Ban Kuraburi	0-23	0-170	0-110	0-21
	Ban Num Khem	0-11	0-5	5-44	5-35
	Ban Thung Ma Phow	26-190	0	0	0
Krabi	Ban Ba Gan	26-900	17->1,600	6-170	0-60
	Ban Tha Phow	2-60	2-50	5-9	4-19
Trang	Ban Yong Star	50-170	4-14	0-4	0-4
Satun	Ban Ba Kan Kai	2-7	4-170	0	0

The Need for the Future Support

From this study, the need for the future support for sustainability in rehabilitated cage farms on the coast of the Andaman Sea, southern Thailand can be divided into three categories:

Technical Support. The cage farmers in this area need the technical support as follows:

Providing seed for grow-out. As mention above, the problem on seed shortage has a major impact on the cage farms on the Andaman coast of Thailand and occurred before the impact of the 2004 tsunami, especially in connection with the grouper seed. High demand for seed and high seed cost resulted from the decline in wild seed. All cage farms in this area used the grouper and red snapper seed collected in the wild, while the sea bass seed was mainly bought from the DoF hatcheries. Therefore, the DoF government sector should pay attention to research and development of the hatchery seed production techniques. As seedling resources are developed, there will be need for fish seed holding centers. Each center should have the dual function of supplying low-cost fish seeds to cage farms, and undertaking nursery and quarantine work to ensure optimal survival rate of the fish seed**.**

Formulated feed development. In response to the limitations and problems associated with trash fish usage for grouper and sea bass aquaculture, new and better practices are being developed. Foremost amongst these is the use of formulated feeds instead of trash fish. The economic benefit of using formulated feeds is that it is more cost-effective than trash fish. Fish grow faster and are healthier in comparison to fish which are fed trash fish because formulated feeds provide a nutritionally complete diet. The Research Institute for Mariculture, Gondol, Indonesia, showed that grouper grew 75% faster when fed formulated pelleted feed compared with grouper fed trash fish. (Sim et al., 2005). Formulated feeds also generate less pollution, since water stability is better and less of the feed is wasted. In turn, this provides a better environment for the fish, leading to a reduction in disease problems.

Disease control and prevention. From this study, the disease outbreak was the major factor affecting loss of production in cage farms in this area. The fish farmers were usually contacted and took the specimen to the closest DoF fishery station, but they were sluggish in their response. Sometimes all the fish died before a DoF technician arrived. Subsequently, most of cage farmers were not consistently helped by the government sector and turned to local wisdom from past experience rather than waiting for the government sector to respond. However, the fish disease monitoring program from the government sector or institutions are still needed by the cage farmers, and this can be promptly resolved if disease breaks out.

Creating supplementary income. The relative government sectors should provide fish farmers with alternative skills so they can work in their communities in areas such as batik painting, home-stay services, and repairing fishing gear.

Training program. To facilitate the initiation of cage culture development, the creation of a core group of functional personnel should be an activity of high priority. This core group should provide the initial personnel capacity in handling farm management, as well as the whole range of tasks of a production farm. It should also be capable of participating in the planning and the subsequent implementation of production and marketing programmes.

Marketing Support

Development of marketing system. Among other circumstances, the marketing system and the basic essential supporting infrastructure play a key role in the well-being of any fishery. The experience gained within the limited time spent in the field has clearly indicated that these fishery aspects in the country indeed need urgent review and, in cases of failure or success, a considerable amount of investigation to establish their underlying reasons. This should be carried out as soon as possible as an ongoing exercise.

Marketing statistics. A representative inventory of the basic information on the biological and economical aspects of cage farms should be kept to serve as a reliable source of data on which future development actions could be reliably based.

Financial Support

Micro-credit arrangement/ revolving funds. It is important to provide fish farmers a low-interest grant for revolving funds that they can borrow for their small business.

Improve compensation package. As mentioned above, the compensation package for cage farms is rather low compared to the loss. Therefore, the compensation levels to replace essential livelihood inputs must be realistic.

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