AQUACULTURE POTENTIAL FOR TSUNAMI AFFECTED VILLAGES

Prepared by

Kevin Hopkins
C. Kwei Lin

August 2005

THAILAND POST-TSUNAMI SUSTAINABLE COASTAL LIVELIHOODS PROGRAM

A Program of the Leader with Associates Cooperative Agreement on Sustainable Coastal Communities and Ecosystems (SUCCESS)

Implemented by the Coastal Resources Center, University of Rhode Island in partnership with the Asian Institute of Technology and the University of Hawaii

Funded by:

Regional Development Mission/Asia
U.S. Agency for International Development
Cooperative Agreement No. 486-A-00-05-00004-00

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1. Introduction

The December 26 tsunami had major impacts on coastal communities in Suk Samram Sub-District of Ranong Province, Thailand. The Post-Tsunami Sustainable Coastal Livelihoods Program, funded in large part by the United States Agency for International Development, was initiated to demonstrate how participatory, issue driven and results-oriented processes can be applied to restart livelihoods and rehabilitate coastal communities affected by the tsunami.

The program is located in the five villages of Tambon Kamphuan that were directly impacted by the December 26th tsunami. The targeted beneficiaries are tsunami-affected individuals and households. One of the programs objectives is to "Re-start livelihoods, especially those that rely on healthy coastal resources." In the preliminary rapid appraisal (PRA), aquaculture was identified as a possible livelihood (Table 1). Many of these aquaculture projects are scheduled to receive partial funding from other agencies.

Table 1. Aquaculture Projects identified in the PRA

Village	Proposed Aquaculture Project	Requested Amount (Baht)	No. of Households
1	None identified in PRA		
2	Group 1: Grouper cage culture	5,171,500	24
	Group 2: Grouper cage culture	5,142,946	32
	Group 4: Mud crab raising	834,750	30
3	Group 1: Fish cage culture	2,450,000	35
	Group 2: Green mussel raising	172,990	13
	Group 3: Green mussel raising	148,295	26
4	Group 2: Green mussel raising	450,000	12
	Group 3: Green mussel raising	1,319,280	23
	Group 4: Fish cage culture	612,000	17
	Group 5: Fish cage culture	749,400	10
	Group 6: Fish cage culture	2,750,085	41
6	Group 1: Mussel cage culture	784,116	12
7	Group 3: Sea-bass culture	1,156,255	16
	Group 6: Frog culture	1,207,000	14
	Group 7: Catfish culture	1,099,960	19
	Group10: Green mussel culture		

Note: Although aquaculture activities are desired and conducted in Village 1, the villagers thought that they could have assistance in only one livelihood area and requested assistance for eco-tourism.

2. Evaluation of Aquaculture Projects and Potential

A team of two aquaculture development specialists from the University of Hawaii at Hilo's Pacific Aquaculture and Coastal Resources Center and the Asian Institute of Technology visited the project site in late July 2005 to evaluate both the economic and environmental feasibility of the proposed projects and to recommend other aquaculture projects, if appropriate. Their terms of reference are in Table 2.

Table 2. Specialist' terms of reference

Mission statement: To provide support to the project in the area of aquaculture development in tsunami affected communities in Ranong Province, Thailand. The scope of the work is to review background information, to assess resource capacity, and to recommend means to achieve sustainable aquaculture in the area. Work will be conducted in close cooperation with the local project team, local government, and communities. Strategies, activities, and schedules will be consistent with USAID rules and regulations.

Activities:
1. To review secondary information resources

2. To assess potential aquaculture sites in local communities by:
a. familiarization with general features of the area;
b. clarify and substantiate the problems and suggested solutions relevant to aquaculture as identified in the PRA;
d. evaluate aquaculture situation – species selection and culture systems, water quality, technical needs, seed supply, feed source and availability, processing and transport;
c. evaluate economic situation – access to capital, potential outputs, markets, costs of inputs, risk assessment;
e. evaluate environmental situation – carrying capacity, resource conflicts including diversion from local consumption to cages (for export), direct impacts of development (dredging, piers, etc); and
f. assist a catfish producers group in preparation of a business plan for use in obtaining funding for a catfish hatchery.

Outputs:
1. Analysis and recommendations of appropriate low-impact aquaculture for each village;
2. Training plan and program for specific topics, number of trainees, appropriate trainers, training materials, logistics and costs;
3. Development a flexible model business plan for small-scale aquaculture operations, and
4. Draft business plan for a small village catfish nursery.

The specialists traveled throughout the coastal areas of all of the villages and adjacent areas to observe on-going aquaculture, environmental conditions and interview the fishermen and those interested in aquaculture (Table 3). After evaluating environmental feasibility, economic data was collected in sufficient detail to prepare preliminary analyses of economic feasibility analyses for selected species.

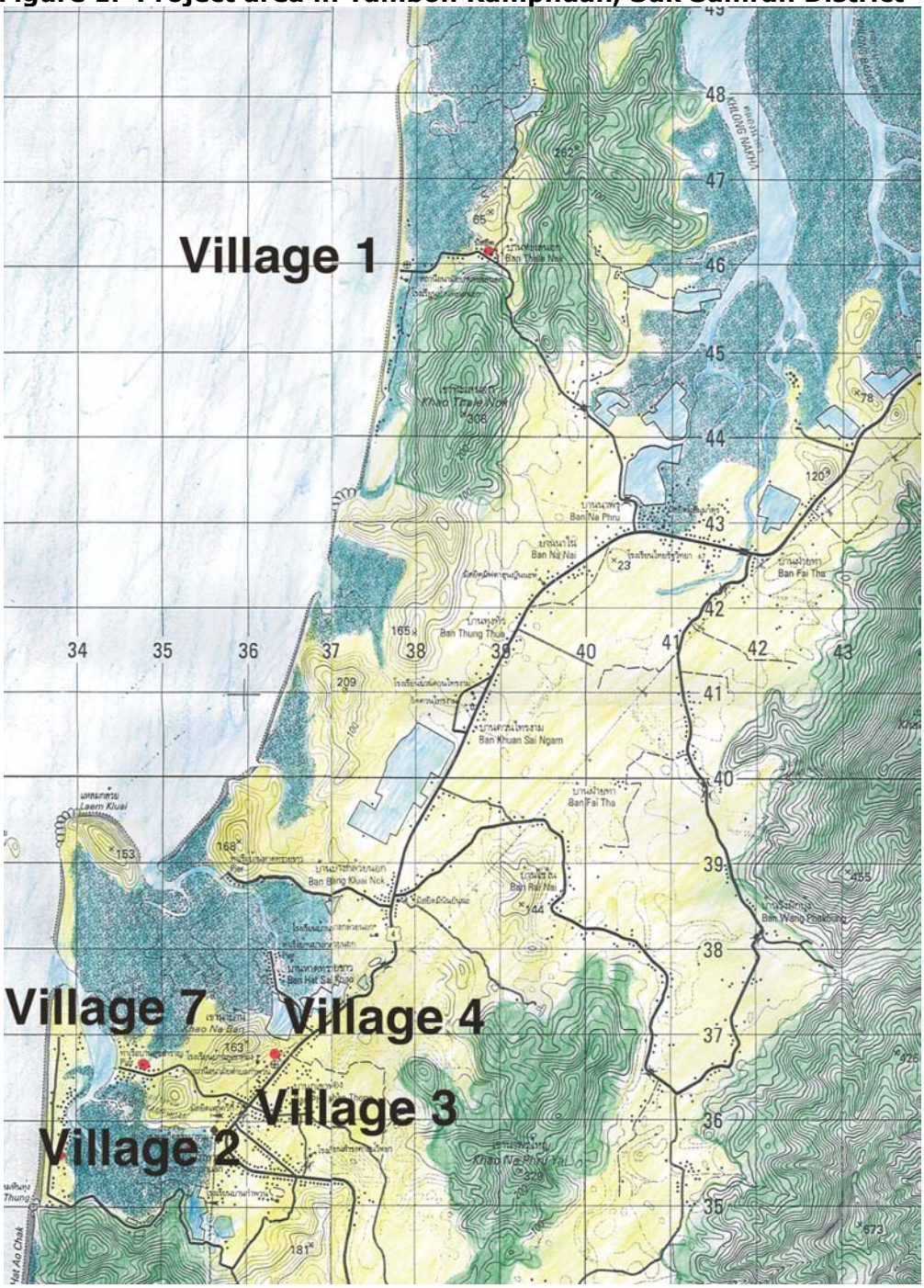
Table 3. Summary of Field Activities

Date	Time	Activity/Interviews
20-Jul	PM	Meeting with Ranong Coastal Aquaculture Center Director and Kasetsaert Univ. Center director
20-Jul	PM	Village 2 - Visit Kasetsart University Center
21-Jul	AM	Klong Naka - Environment observation
21-Jul	PM	Village 4 - observe fish sorting at pier
21-Jul	PM	Klong Kluai - Environment observation
21-Jul	PM	Village 4 - shrimp farm
22-Jul	12:30	Tambon Administrative officer
22-Jul	14:00	Observe CHARM meeting
23-Jul	9:30	Village 7 - catfish farmers and hatchery site
23-Jul	11:00	Village 7 - mussel farmers at pier
23-Jul	14:00	Village 2 - grouper farmers at pier
23-Jul	15:30	Village 4 - mussel farmers at project office
23-Jul	16:30	Village 4 - grouper farmers at office
24-Jul	11:00	FAO consultant
24-Jul	PM	Two catfish hatcheries near Ranong. Also FW shrimp.
25-Jul	AM	Roadside stand shellfish, 20 km N of office
25-Jul	AM	Village 3 - mussel farmers at project office. 1 also deals in marine ornamentals
25-Jul	AM	Village 6 - mussel farmer at office.
25-Jul	PM	Village 3 - Holding facility and koi tank
25-Jul	PM	Village 1 - meet with village head, visit shore area
26-Jul	AM	Visit Kuraburi market - fish section
26-Jul	AM	Visit trawler dock at Kuraburi pier
26-Jul	AM	Meet with Amphur Fishery Officer at Ban Fai Thai market, Tambon Naka
26-Jul	PM	Meet again with Tambon Administrative Officer

3. General Environmental Considerations

The project area is shown in Figure 1. Klong Naka, in the upper right is outside of Tambon Kamphuan but is still part of Suk Samran District. Village 1 Ban Talae Nok is located west of the lower reaches of Klong Naka. Village 2 Ban Tap Nua is located on

Figure 1. Project area in Tambon Kamphuan, Suk Samran District



a spit of land at the lower left of the map. Village 3 Ban Kam Phuan is the Tambon Center. Although not located directly on the coast, the fishers from this village had houses near Village 2 and lost them all to the tsunami. Village 4 Ban Phukhao Thong is located north of the Village 3 on Klong Kluai. Village 7 Ban Hard Sai Hao is located across the klong from Village 2. Detailed information about these villages including population, occupations, tsunami damage, etc. can be found in the PRA and other project reports.

The PRA and subsequent interviews showed a high level of interest in aquaculture in all of the villages, particularly mussel culture using rafts, cage culture of marine fish and catfish culture. Although both mud crab culture and frog culture had been identified in the PRA as activities of interest, market concerns and the availability of seed have greatly diminished such interest. Thus, the commercial culture of frogs and mud crabs and are not considered any further in this report.

As the climate is conducive to aquaculture of the desired species, the other key environmental requirements for both mussel culture and cage culture of marine fish are shelter from waves, adequate depth below the rafts and cages at low tide (a minimum of 3 meters is desired), adequate area for passage of boats, and minimal impact of freshwater run-off on salinity (i.e., salinity should not drop below 15 ppt).

Based on these criteria, none of the waters adjacent to the program's villages are particularly suitable for cages or rafts. Thus, except for a few cages and rafts in very limited areas within the program's villages, cage and raft culture systems will need to be located in Klong Naka, as has been suggested by most of the interested persons. The site evaluation by village follows:

- Village 1 - No protected waters within the village boundaries

- Village 2 – Area available for cages and rafts is very limited at low tide (see figure 2). High velocity and influence of freshwater would negatively affect cages in the proposed cage area near the new pier. Fish were previously grown in cages near the mouth of the klong but houses in that area were destroyed and the replacement homes are too far away to provide security. Cages could still be placed near the mouth of the klong if a guard house was constructed.

- Village 3 – same comments as for Village 2

- Village 7 - Same comments as for Villages 2 and 3 in regards to rafts and cages. Additionally, expansion of catfish culture in land-based tanks is proposed. A potential problem with this expansion is limited freshwater supplies and wastewater disposal. Further analysis of freshwater supplies is required.

- Village 4 - Area available for cages and rafts is very limited at low tide (see figure 3) and water is too shallow. High velocity and influence of freshwater would negatively affect cages. Further, heavy pollution load (solids and dissolved organics) result from fish processing and household waste. The fish processing wastes and by-catch could be used as a feed stock but, at present, it is just discarded. Recent attempts to grow fish in cages towards the mouth of the klong were unsuccessful.

Figure 2. Low tide in Village 2. Note cages in background.

Figure 3. Klong Klui adjacent to Village 4. Note limited area for cages.

- Klong Naka, in Tambon Naka has been proposed as the location for cage culture and mussel rafts for Villages 1, 3, 4, and 7. We suggest that consideration also be made for the Village 2 cages to be placed in this area. Klong Naka is much larger and deeper than the other klongs. Mussel rafts and cages have been successfully operated in Klong Naka for a number of years. At present, the number of rafts and cages in the Klong is greatly reduced as most of them were located near the mouth and were destroyed by the tsunami. The current growth rates of mussels are reportedly much greater than before. This indicates that carrying capacity will have to be monitored to ensure sustainability. Figures 4 and 5 show typical mussel rafts and fish cages, respectively.

Figure 4. Mussel raft in Klong Naka

The effects of activities on the lands adjacent to Klong Naka should not have a significant effect on aquaculture in the estuary. The klong is located, in large part, within Lam Son National Park so development is restricted. Shrimp farms are located in the upper reaches of the mangroves and filled by pumping (Figure 6). Given the limited area occupied by these farms, their effect should be minimal on the estuary as a whole except for the escape of white shrimp. The increasing presence of filter nets (both stationary and motorized) is of much more concern.

Figure 5. Typical cage system in Klong Naka.

Figure 6. Pump station for shrimp farms. Most shrimp farms in Suk Samran are located above the tidal areas.

4. Preliminary Economic Analyses of Typical Systems

Mussels – Mussel culture appears to be an excellent crop for the Kamphuan villagers. Technological requirements 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 the area. The typical mussel raft is approximately 9 -15 m x 18 - 20 m, constructed from 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. Based on figures obtained from several sources, a typical summary budget for a raft is presented in Table 4. In addition to the concern about carrying mentioned previously, there appears to be little guidance and information available to the farmers on ecologically sound site selection, construction and operation. The DOF has indicated that they are willing to provide training in mussel culture.

Table 4. Summary annual budget for one mussel raft

Capital Cost Per Raft	35,000	Baht
Average Life	3	years
Depreciation/Replacement	11,667	Baht per year
Crops per year	1	
Operating Cost (seed + string)	25,000	Baht per crop
Gross sales per crop	70,000	Baht
Gross return to capital & labor	33,333	Baht per year per raft

Note: Gross return = Gross sales minus operating cost and depreciation/replacement

Cage Culture of Fish - Cage culture of marine fish, particularly grouper, is a "step up" in technological sophistication from mussel farming requiring continuous security, daily feeding and maintenance. The typical fish cage is 3 m x 3m x 2m deep, usually grouped in an array of 30 cages. Each array has a platform topped with a simple hut for the caretaker/security guard. Seed stock can be obtained by fishing or can be purchased. The current seed supply is problematic because the fishermen are afraid to venture too far off-shore. 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. Middlemen purchase the fish at the cages for transport to markets outside th area. Tables 5, 6, and 7 provide a summary of the capital costs, operating parameters, and a summary budget for cage culture. It is must be emphasized that the most efficient management system for the cages would be one cages (preferably two in order to accommodate different sizes of fish) per household. Joint ownership would probably be highly problematic given the inputs (labor, seed and feed) required.

Table 5. Summary of capital costs for one fish cage

Capital Cost of Cage	3,500	Baht
Capital Cost of Shelter (1 per 30 cages)	30,000	Baht
Total Capital Cost per Cage & Shelter	4,500	Baht
Life Expectancy	4	yrs
Depreciation per Cage & Shelter	1,125	Baht/yr

Table 6. Summary of operating parameters for one cage

Culture period	8	months
Seed cost	35	baht per fish
Stocking rate (fish per cage)	100	per crop
Size at harvest	1.1	kg
Survival	75%	
Total number of fish produced	75	fish/cage/crop
Total weight produced	83	Kg/cage/crop
Reported feed usage rate	3.0	kg/cage/d
Total Feed Used per crop	720	Kg/cage
Feed cost	8	baht/kg

Notes: Although the culture period is only 8 mo., probably only one crop per year will be raised. The reported feeding rates indicate an FCR of almost 9:1 . This is very high but may be realistic given the quality of the feed stock. Improved feeds will improve the feed conversion.

Table 7. Summary annual budget for one fish cage (assumes 1 crop per year)

Number harvested (no. stocked x survival)	75	fish per cage
Sales price of grouper	210	per fish
Total revenue (no. harvested x sales price)	15,750	Baht
Less: Seed cost	3,500	Baht
Less: Feed cost	5,760	Baht
Less: Depreciation	1,125	Baht
Gross return to labor & mgt per cage	5,365	Baht

Notes: If the villagers catch their own seed stock and trash fish, returns would be higher.

Catfish Culture - Interest in hybrid (*Clarias garipenus x C. macrocephalus*) catfish farming is most prevalent in Village 7 where the farmers have already undergone training in catfish culture and hatchery operation, selected a site and designed a hatchery, and requested over Baht 600K to build and operate it. Farmers from Villages 1, 2,3 are also interested.

According to the villagers, a catfish hatchery is necessary because no private catfish hatcheries operate in the Kamphuan area. But two private catfish hatcheries operate within 70 km of the site. However, these hatcheries produce only *C. garipenus*, not the hybrid desired by the villagers. The reason, according to the hatchery operators, is that buyers in western Thailand do not differentiate between the hybrid and *C. garipenus*. If this is correct and the fish are consumed or sold locally, it may make no economic sense to maintain two pure lines to produce the hybrid**.** Alternately,

A fairly detailed analysis was made of the proposed hatchery plans. The plans are patterned after the relatively large-scale catfish hatchery in Central Thailand where the villagers underwent training. The design is lacking some key elements and is grossly over-priced. Further, hybrid catfish fingerlings are available from Central Thailand at a very low price and small-scale hatcheries can be easily developed using production tanks. Thus, there are major questions about the need and feasibility of the large-scale hatchery. It would be more prudent to identify a reliable source of fingerling catfish in central Thailand and develop an effective transport system. The money "saved" by not building the large scale hatchery could be used to expand production tanks and thereby, increasing benefits to more households. However, if a local *Clarias* hatchery is still desired, reduce the size to a backyard scale which should cost no more than $5,000

The typical catfish production unit is a 20 m^2 concrete tank, 0. 4 m deep, with galvanized iron roof. Water is obtained from potable sources. This is of great concern as the cost of water is substantial and, more importantly, potable water supplies are limited. Thus, expansion of catfish farming will require identification and development of alternate water supplies (which was not yet done). Capital costs, operating parameters, a summary budget for a typical catfish tank are shown in Tables 8 to 10.

Table 8. Capital cost of a typical catfish tank system

Capital cost of concrete tank	5,000	Baht
Capital cost of roof	3,000	Baht
Retention pond/garden for wastewater treatment	2,000	Baht
Total Capital Cost	10,000	Baht/system
Life Expectancy	10	yrs
Depreciation per year	1,000	Baht

Table 9. Operating parameters for a catfish tank

Culture period	6	Months
Crops per year	2	
Seed cost	0.5	Baht per fish
Stocking rate	2000	per tank per crop
Size at harvest	0.33	kg
Survival	80%	
Total production per crop	533	Kg/tank/crop
FCR	1.5	
Feed usage per crop	800	Kg/tank/crop
Feed cost	18	Baht/kg
Water exchange frequency	1.5 times	per week
Amount exchanged	50%	
Total water used	144	m^3/crop
Water cost	5	Baht/m^3

Table 10 . Summary annual budget for one catfish tank (2 crops per year)

Weight harvested	1,066	kg/tank/yr
Sales price	35	Baht per kg
Total revenue	37,333	Baht per year
Less: Seed cost	2,000	Baht per year
Less: Feed cost	28,800	Baht per year
Less: Water cost	1,440	Baht per year
Less: Depreciation	1,000	Baht per year
Gross return to labor & mgt	4,093	Baht/tank/year

5. Recommendations

We propose that this program support aquaculture projects as follows:

Priority 1 – High potential projects that show immediate results.

The first priority of the program should be to support existing farmers who lost their grouper cages and rafts. This effort should be in collaboration with other projects that have already committed funds. Although the program area does not include Klong Naka, its inclusion should be considered.

- Revolving fund to supplement CHARM and Japanese mussel projects
- Revolving fund to supplement CHARM and Rotary cage projects
- Revolving fund for construction of catfish tanks
- Funds for small-scale catfish hatchery, if still desired by community.
- Small-scale fish feed mills using "trash" fish and local ingredients

The total cost of the Priority 1 projects is approximately Baht 7.4 million of which Baht 6.5 million is for revolving funds with only Baht 0.9 million as grants. This does not include Baht 200 thousand for the backyard catfish if the decision is made to construct it to improve seed availability. Details are included in Appendix A.

Table 11. Summary of Priority 1 Projects

Project	Amount (Baht million)	Number of Villages	Number of Households
Mussels	1.8	5	139
Fish Cages	3.1	4	150
Feed Mills	0.9	6	
Catfish	1.6	4	30

Priority 2 – Projects that improve long-term sustainability

The priority projects should concentrate on implementing new technologies that reduce and/or manage environmental impact

- Demonstrate barrel and pipe rafts and cages instead of styrofoam and wood - This project would demonstrate a method to reduce wood and styrofoam debris which pollute coastal water ways. The estimated cost is Baht 100 thousand
- Demonstrate usage of catfish wastewater for irrigation
  It is suggested that a either a demonstration system be constructed at a cooperating farm or at the catfish hatchery. The cost would only be slightly more than a typical 2 tank culture system (estimate Baht 60 thousand)
- Monitoring of Klong Naka
  This bay accommodates a large number of fish and mussel farmers. Apparently, water quality and other environmental conditions affect and are affected by both the aquaculture operations and the commercial fisheries. But systematic monitoring has not been implemented to determine the carrying capacity of the bay. KU's resource center has submitted a proposal to conduct this activity for Baht 600 thousand

Priority 3 – Projects that expand livelihood options

As carrying capacity of the local klongs is approached, other aquaculture opportunities could be developed by examining new species and systems to further diversify economic activity.

- Breeding marine ornamental fish
  The local fishers from village 3 have collected fry of marine butterfly fish from coastal waters and rear them in cages for the ornamental trade. By building a small-scale hatchery to produce fry for other fishers to nurse could reduce fishing pressure on wild stocks while providing additional income to local fishermen. The estimated cost would be Baht 200 thousand. Additionally, a tour of fish breeding labs by the fishers would be desirable.
- Breeding and culture of sweet snail (*Babylonia* sp.)
  The sweet snail commands a high market price and the technology for its culture has already been developed. KU has expressed an interest in developing a demonstration facility for this species at an estimated cost of Baht 200 thousand.
- Freshwater pond systems
  Some fishermen who reside inland also have farms into which pond systems could be integrated. It is proposed that a small demonstration and training project be started to obtain fry of freshwater species such as tilapia and pacu (*Colossoma* sp.) and to offer training in their culture. Estimated budget is Baht 200 thousand.

Appendix A
Details of Priority 1 Recommendations

Supplement On-Going Mussel Raft & Fish Cage Projects - CHARM (the Coastal Habitats and Resources Management Project), Rotary and a Japanese group have already provided over Baht 2 million for aquaculture projects in Kamphuan. However, based an analysis of capital costs and operating costs these projects are severely under-funded given the number of recipients.

As an operating structure including advisory groups already exists and potential farmers have been identified, we could have a major impact with relatively little lag time. We suggest that supplemental funding be provided to the existing projects. As "capital" costs have been covered in large part by grants from the other funding agencies, we suggest that the difference (primarily operating costs for the first production cycle) be provided through a revolving fund. This will enable each household to supplement their income by approximately 11,000 baht per year. For mussels, we suggest. providing Baht 1.8 million for 139 households while the fish cages would require Baht 3 million for 150 households (see tables 12 and 13)

Table 12. Suggested supplemental funding of mussel rafts (3 households per raft)

	Village #1	Village #3	Village #4	Village #7	Village #6	Total
From PRA Appendix 9						
Households	-	39	35	??	12	
Amount Requested	-	321,285	1,769,280	??	784,116	
Suggested Plan						
Members (CHARM or Japan)	24	38	32	33	12	139
Number of Rafts	8	13	11	11	4	47
Capital Cost (35,00 baht/raft)	280,000	455,000	385,000	385,000	140,000	1,645,000
Initial Operating Capital (25,000 baht per raft for the first crop)	200,000	325,000	275,000	275,000	100,000	1,175,000
Total Investment Capital + Initial Operating	480,000	780,000	660,000	660,000	240,000	2,820,000
Already Available (CHARM or Japan)	200,000	280,000	270,000	150,000	150,000	1,050,000
Amount Required to Meet Need	280,000	500,000	390,000	510,000	90,000	1,770,000
Net return per household per year	11,111	11,404	11,458	11,111	11,111	11,271

Table 13. Suggested supplemental funding of fish cages (2 cages per household)

	Village #2	Village #3	Village #4	Village #7	Total
From PRA Appendix 9					
Members	56	35	68	16	175
Amount Requested	10,314,446	2,450,000	4,111,085	1,156,255	18,031,786
Suggested Plan					
Members (CHARM or Rotary)	45	22	67	16	150
Number of Cages	90	44	134	32	300
Capital Cost (4,500 baht/cage)	405,000	198,000	603,000	144,000	1,350,000
Initial Operating Capital (9,260 baht per cage for the first crop)	833,400	407,440	1,240,840	296,320	2,778,000
Total Investment	1,238,400	605,440	1,843,840	440,320	4,128,000
Already Available (CHARM or Rotary)	300,000	150,000	449,940	150,000	1,049,940
Amount Required to Meet Need	938,400	455,440	1,393,900	290,320	3,078,060
Estimated net per household per year	10,730	10,730	10,730	10,730	

Small-scale feed mills - In the villages, considerable quanitities of trash fish currently go to waste and pollute the klongs because there is not an easily usable system to process that trash fish into fish food. We propose building small fish feed mill in each village consisting of a small grinder and extruder inside a weather-proof shed. The estimated cost of each mill would be about Baht 150K. Details will be provided by AIT fish feed specialists.

Catfish Production Tanks - The PRA identified 19 potential catfish farmers in Village 7. Additionally, farmers from villages 1, 2, and 3 attended catfish training. As the project has already raised expectations re: support for catfish, we suggest that up to 30 households be provided access to sufficient revolving funds to construct 2 tanks each and operate them for one cycle for a single cycle. Details are provided in Table 14.

Table 14. Required funding for catfish production tanks (2 tanks per household)

	Village #4	Other Villages	Total
Households (estimate)	19	11	30
Number of Tanks	38	22	60
Capital Cost (10,000 baht/tank)	380,000	220,000	600,000
Initial Operating Capital (16,120 baht per tank for the first crop)	612,560	354,640	967,200
Total Investment	992,560	574.640	1,567,200
Already Available (CHARM or Rotary)	0	0	0
Amount Required to Meet Need	1,393,900	290,320	1,567,200
Estimated net annual return per household (based on 2 tanks and 2 crops per year per tank)	8,186	8,186	

Catfish Hatchery - A small-scale catfish hatchery capable of producing 500K to 1 million fingerlings per year should cost no more than Baht 200 thousand to construct. It is recommended that brood fish be obtained from central Thailand. The females can be reused for future spawns while males will have to be obtained regularly (if the hybrids are being produced. This is still to be determined.) Primary components of the hatchery will consist of a shallow well, access to domestic water, water reservoir tanks, 3 to 6 brood tanks, and about 12 to 15 nursery/*Moina* production tanks. The tanks will need to be covered.