Working Paper

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Integrated Natural Resource Management & Livelihood Paradigms in Recovery from the Tsunami in Aceh

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Southeast Asia

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

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Summary

The December 2004 tsunami brought Aceh and its coastal zone to the forefront of public interest and discussions on the environment and development. Conversion of mangrove forest to brackish-water aquaculture (*tambak*) in the 1980s almost certainly increased the death toll from the tsunami. The devastation was unprecedented in recorded human history. Thousands of hectares of brackish water aquaculture (*tambak*) mature for harvest, which is the main livelihood for the NAD province coastal community, were swiped away in minutes. *Tambak* rehabilitation is a strategic intervention aimed at restoring the livelihoods of thousands of people living in coastal areas of the province. Although external assistance is required, post tsunami *tambak* aquaculture rehabilitation efforts in NAD province by external parties (such as donor institutions and development drivers) have been hindered by their limited knowledge of the socioeconomic and environment aspects of *tambak* aquaculture; hence, to determine the appropriate interventions for *tambak* rehabilitation which will restore community life post tsunami.

The objective of this study is to contribute to the debate on rehabilitation strategies by clarifying the social, economic and legal issues that relate to the development of *tambak*s in the mangrove zone. Five aspects of *tambak* systems explored in the study: *tambak* holding patterns in NAD province pre-tsunami, job opportunities in *tambak* aquaculture, *tambak* production systems, legal aspects of *tambak* ownership in NAD province and *tambak* management patterns, pre and post tsunami. Data collection was conducted over 20 days (2-21 December 2005) using the Rapid Rural Appraisal technique; secondary data documentation, field observation, group interviews, and focus group discussions using semi-structured interview guidelines.

Brackish water aquaculture in Aceh started in the 1940s by *Ulee Balang*, in the form of traditional earthen pond systems that depended on tidal water exchange for wild seed supply and maintenance of water quality. Brackish-water pond establishment along the north-east coast grew rapidly in the late 1970s in line with the development of semi-intensive shrimp farming. Extensive conversion of mangrove forest for shrimp farming in Aceh began in the early 1960s, when a Medan-based investor provided a credit scheme for shrimp culture to groups of 40 farmers.

With regard to property rights, not all *tambak* are established on privately owned land. It is estimated that 19.8% of the *tambak* area in the 12 villages under study are established on non-private land and only 36.5% of those on privately-owned land have land certificates. Land with this kind of secured title is mostly found in the urban areas closest to Banda Aceh (Tibang and Lambaro skep, 99.5% and 44.9% respectively) and Pidie (Baroh Lancok, 43.9%). In rural areas, the amount of private land with land certificates is very low, less than 15%. It is important to develop a sustainable strategic livelihood for the future on lands where people are vulnerable to eviction.

The cost of *tambak* rehabilitation per hectare is estimated at between Rp. 5.89 million and Rp 32.41 million depending upon the level of damage and the method used; capital intensive (using back hoe) or labor intensive (done manually). Labor intensive rehabilitation will never work to reconstruct severely damaged *tambak*, while other level damage can do both.

Ex ante financial assessment of brackish water pond production after reconstruction finds out that traditional systems practiced by the largest *tambak* operator in the province, are still profitable under 15% discount rate, assuming that the survival rate for shrimp fry and milk fish is 48% and 70% respectively, with initial capital ranges from about Rp 18.5 million to Rp 45 million per hectare (cost of establishment and working capital). Hence, in normal conditions, this amount is affordable. However, in situation such as exists in Aceh at present, it is not affordable for smallholder shrimp/fish farmers. At the other extreme, an intensive *tambak* system requires more initial capital ranging from Rp. 57.86 - 84.1 million. This provides the highest profitability, although it assumes a production scenario whereby there will only be seven effective years out of 11.

All these calculations do not internalize the social cost of mangroves lost, the environmental and social damage associated with problems of pollution, the public health risks and salinization caused by intensive shrimp farming. These factors are in stark contrast to the values of communal ownership, coastal protection and domestic food supply intrinsic to intact mangroves. These values need to be monetized to provide more comprehensive information to national governments and international funding organizations which have been working on *tambak* rehabilitation in Aceh. Institutions that protect local communities and the environment from short term profit-makers must be developed and supported and their rules must be enforced. Although estimates indicate that the 'social value' of intact mangroves is much higher than the 'private value' of converted mangroves, there is no mechanism to provide benefits which might prompt those with the right to convert mangroves to reconsider their decisions. Part of the tsunami damage can thus be seen as the result of institutional failure to internalize externalities.

From an employment generation point of view, brackish-water aquaculture is a good option because it has a reasonably better return to labor than that of other agricultural activities in rural areas. Brackish-water aquaculture requires 395–813 person-days per hectare per year to operate, depending on the technology. It appears that intensive systems would provide more employment for local communities, however this does not always happen in reality. The experience in Aceh is that *tambak* operators are often not from the local community and so very little local labor is employed. This can create tension between local communities and migrant laborers working the intensive shrimp farms.

The capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human livelihoods can no longer be taken for granted. Socio-ecological resilience must be understood at a broader scale and actively managed and nurtured. Incentives for generating ecological knowledge and translating this into information that can be used in governance are essential. The 'human causation' element of the tsunami impact has received a lot of attention for the most coastal zone which lost its protective mangroves in the 1980s due to conversion to other commercial uses. Attention to 'human causation' is in line with a general tendency that judges the seriousness of an environmental loss by what caused it. The effects on the rest of the coast are more difficult to quantify, but are still important in the debate. The social cost of past conversion of mangroves to *tambak*s was previously estimated primarily based on the value of open-sea fisheries. Therefore, *tambak* rehabilitation should consider the balance between the economic potential of coastal resources and environmental problems that could occur in the future as a result of exploiting coastal resources. The conflict between public and private interest should be internalized into the rehabilitation process.

Multilevel social networks are crucial for developing social capital and for supporting the legal, political, and financial frameworks that enhance sources of social and ecological resilience.

Keywords

Brackish water aquaculture, economic assessment, land holding, mangrove, tsunami, return to labor.

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Acronyms

Keuchik:	village head
Mawah:	local term (Aceh) for shared crop systems
Muenasah:	*community hall that can be use as prayer house*
NAD:	Nanggroe Aceh Darussalam
PODES (Potensi Desa):	Village statistics published by National Bureau of Statistics
SHM (Sertifikat Hak Milik):	land title deed
Tambak:	brackish water aquaculture
Toke:	trader
Ulee balang:	guard

1. Introduction

1.1 Post Tsunami: A lament for brackish water aquaculture in NAD Province

At the end of 2004, a single gigantic tsunami wave, triggered by an Indian Ocean earthquake, killed large numbers of people and devastated coastal communities and all productive capital in the Province of Nanggroe Aceh Darussalam (NAD). Thousands of hectares of brackish water aquaculture (*tambak*) mature for harvest, which is the main livelihood for the NAD province coastal community, were swiped away in minutes. An assessment conducted by the Food and Agriculture Organisation of the United Nations (FAO) (Philip and Budiman, 2005: 34-37) noted that 20,429ha or 42.9% of *tambak* in NAD province lost its production capacity. Approximately 7,300ha were severely damaged, with no means for immediate restoration. Meanwhile, approximately 1,000ha of *tambak* were permanently inundated due to the coastline shift inwards. The main infrastructure and facilities for *tambak* aquaculture, such as 810km (66.8%) of irrigation channels and 193 units (out of 223) hatcheries, were severely damaged.

The damage was not limited to the physical loss of *tambak*. *Tambak* farmers whose land was swept away in the tsunami lost both their livelihoods and their working capital. This significantly affected the financial capital available in the community, including capital from the proprietors (*toke*) who provide most of the working capital and marketing for the farmers' products. The hopes of the *toke* for a profit margin from the harvest were shattered along with the wrecked *tambak*. In addition, the capital loaned to farmers would not be returned in the near future or at all, due to the disaster.

1.2 *Tambak* rehabilitation issues, study objective and scope

Tambak rehabilitation is a strategic intervention aimed at restoring the livelihoods of thousands of people living in coastal areas of the province, especially those who rely on tambak production. It is not initiated by the farmers or communities themselves, as none have survived the tsunami. External assistance is required, from government and/or international donors.

Post tsunami *tambak* aquaculture rehabilitation efforts in NAD province by external parties (such as donor institutions and development drivers) have been hindered by their limited knowledge of the socioeconomic and environment aspects of *tambak* aquaculture. It is difficult for donors and development drivers to define rehabilitation priorities when there is limited information on *tambak* holding patterns and *tambak* aquaculture practices in NAD province before the tsunami. Environmental issues related to the *tambak* aquaculture system, such as the environmental impact of *tambak* aquaculture and conversion of mangrove forest into *tambak* aquaculture area, have influenced *tambak* aquaculture development intervention. Knowledge of the above is important for donors and development drivers so that they can determine the appropriate interventions for *tambak* rehabilitation which will restore community life post tsunami. The objective of this study is to contribute to the debate on rehabilitation strategies by clarifying the social, economic and legal issues that relate to the development of *tambak*s in the mangrove zone. Five key aspects are to be addressed:

1) Land holding patterns in NAD province pre-tsunami.
   (a) Which *tambak* farmer groups are most affected by the tsunami?
   (b) What proportion of *tambak* is held or owned by investors from outside Aceh?
   (c) What is the socio-economic standard of life for *tambak* farmers compared to other community groups such as fishermen and paddy farmers?

2) Job opportunities in *tambak* aquaculture.
   (a) Is small-scale *tambak* aquaculture able to provide economic benefits to poor families in the community surrounding the *tambak* area?
   (b) What is the nature of the relationship between *tambak* workers and owners?

3) *Tambak* production systems.
   (a) What was the *tambak* aquaculture system before the tsunami disaster?
   (b) Is rehabilitation economically feasible for each aquaculture system?

4) Legal aspects of *tambak* ownership in NAD province and a review of government controlled *tambak* aquaculture at the site.

5) *Tambak* management patterns, pre and post tsunami.
   (a) How can *tambak* aquaculture be financed?
   (b) Is there a financial institution able to finance *tambak* enterprise, such as investment credit, working capital credit, etc in NAD province?
   (c) How are *tambak* products marketed and what is the role of each existing market agent?
   (d) What is the condition of the marketing and financial institutions post tsunami?
   (e) Is there any involvement from private entrepreneurs in *tambak* rehabilitation efforts?

1.3 Methodology and Approach

The study applied rapid assessment methods to obtain information, data and knowledge on the five aspects outlined above. Data collection was conducted over 20 days (2-21 December 2005) using the Rapid Rural Appraisal technique; secondary data documentation, field observation, group interviews, and focus group discussions using semi-structured interview guidelines (refer to Appendix 1). At the provincial level, data collection aimed to obtain information about the general conditions for *tambak* aquaculture in NAD province and the impact of the tsunami. At the regency level, the study selected six *kabupaten* (regencies) with a significant *tambak* area and which suffered greatly from the disaster. From the six selected regencies, ten *kecamatan* (districts) that suffered serious damage were selected. At the village level, from those ten *kecamatan*, 12 villages that were badly damaged were selected.

1.4 Study Site

Table 1 and Figure 1 show the study area and its characteristics, with primary data collected from observation and focus group discussions (FGD). The selected villages (desa/kelurahan) include *tambak* aquaculture sites in urban areas (around Banda Aceh and Lhok Seumawe city) and rural areas in Aceh Besar, Pidie, Bireun and North Aceh Regency. The population in the study site varies between 633 in Kuala Meiraksa Village to 4,151 in Lambaro Skip Village. Population density also varies from 58 people/km^2 (in Gampong Baro Village) up to 2,606 people/km^2 in Lam Teungoh Vilage.

The level of *tambak* damage in the study site varies from 45% to 100%. The most damaged *tambak*s are mainly located in the north of NAD province. Since most of the village communities rely on *tambak* aquaculture (refer to Figure 2), *tambak* damage has had a significant impact on these communities.

Although not all households in the study site coastal area own a *tambak*, 69% (2,141 households) of the total number of households in 12 villages of the study site rely on *tambak* for their livelihoods, 18% (559 households) rely on fishery catchments and 13% (403 households) gain income from other activities (farming, trades, employees, etc). Figure 2 shows the composition of the households in the study site based on their main revenue source. Of those whose livelihood depends on *tambak* aquaculture, the majority are *tambak* workers or managers who cultivate *tambak* on another person's land under a profit sharing system.

Table 1 Study sites: villages, population, and the extent of brackish water pond

City/ Regencies	Kecamatan (district)	Villages	Population 2004 total	Brackiswater pond area (ha)	Estimate of tsunami damage	
					ha	%
Kota Banda Aceh	Kec. Syiah Kuala	Tibang	1,198	130	130	100%
	Kec. Kuta Alam	Lambaro Skip	4,151	150	150	100%
Kab. Aceh Besar	Kec. Masjid Raya	Lamnga, Gampong Baro, dan Neuheun	2,910	192	192	100%
	Kec. Peukan Bada	Lam Tengoh	912	50	50	100%
Kab. Pidie	Kec. Kembang Tanjong	Lancang	1,469	216	194.4	90%
	Kec. Bandar Baro	Baroh Lancok	1,621	207	144.9	70%
Kab. Bireun	Kec. Samalanga	Meunasah Lancok	126	43	30.1	70%
	Kec. Jeunib	Teupin Keupula	582	85	51	60%
Kab. Aceh Utara	Kec. Seunedon	Matang Lada	809	260	130	50%
Kota Lhok Seumawe	Kec. Blang Mangat	Kuala Meuraksa	633	100	45	45%
			14,411	1,433	1,117.4	78%

Sources: Potensi Desa Provinsi NAD 2003 and other primary data collected through focus group discussion in each of the villages being studied.

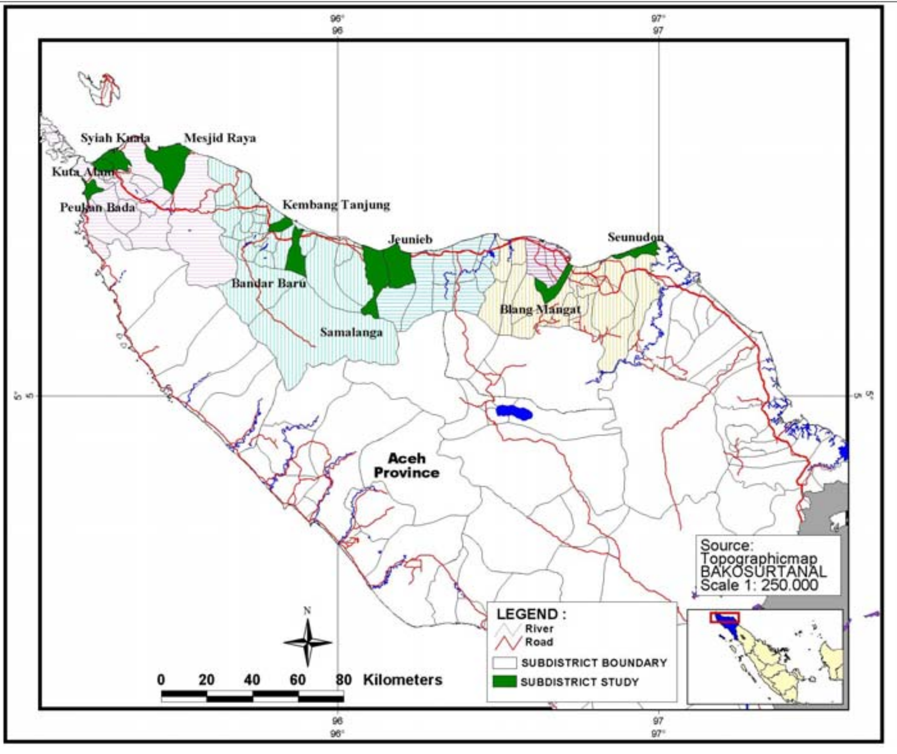
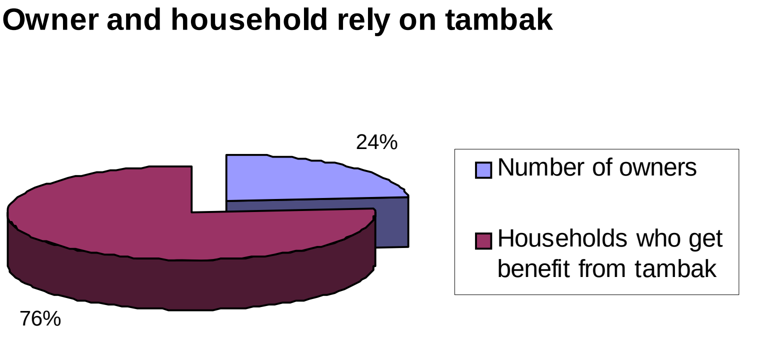


Figure 1. The study sites in the province of Nanggroe Aceh Darussalam



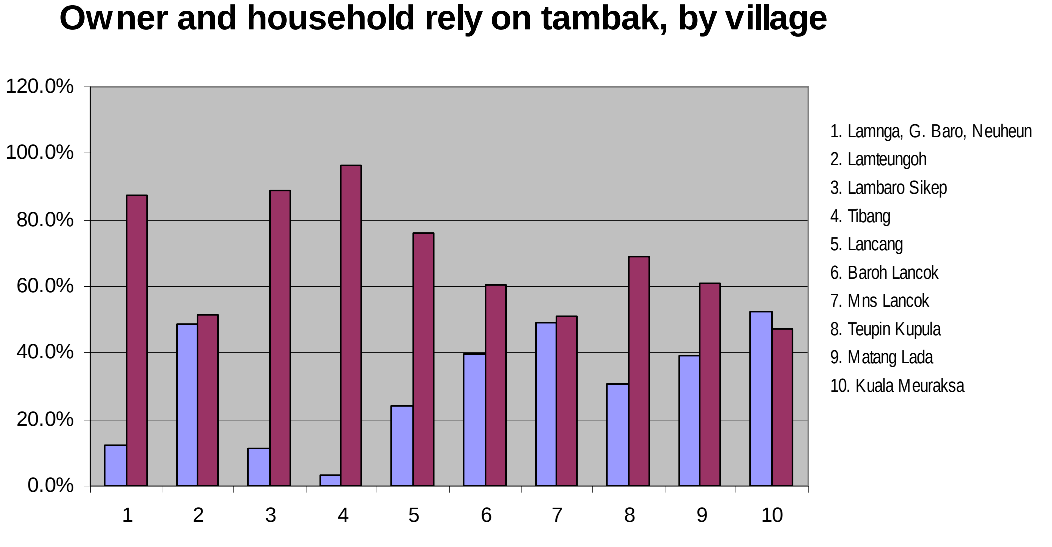


Figure 2. Proportion of household with tambak and population

1.5 Report Organization

This report consists of six chapters. The chapter following the Introduction contains a review of *tambak* aquaculture in NAD province, including *tambak* aquaculture development pre tsunami, land holding and ownership, *tambak* aquaculture systems, production systems, capital and marketing. The chapter following this is a review of *tambak* economies that includes *tambak* production value, production cost, farmers' income and job opportunities. The subsequent two chapters are a review of *tambak* aquaculture post-tsunami and *tambak* rehabilitation, followed by the conclusion and recommendations.

2. Tambak Aquaculture in Aceh

2.1 Brackish water *aquaculture* (*tambak*) in Aceh and mangrove forest conversion

Brackish water aquaculture in Aceh started with traditional earthen pond systems that depended on tidal water exchange for wild seed supply and to maintain water quality. It started in Jeunib and Samalanga (Bireun) and Seunedon and Baktiya Barat of (Aceh Utara) in the 1940s by *Ulee Balang*. This type of *tambak* aquaculture was further developed along the Aceh Eastern coast. *Tambak* aquaculture in Bandar Baru District Pidie Regency was initiated in the early 1950s. In Neuhuen, Lamnga, and Gampong Baru village of Mesjid Raya District, Aceh Besar Regency, *tambak* aquaculture has been known since 1963, marked by the establishment of a *tambak* aquaculture farmer group. T*ambak* aquaculture in the surrounding areas of Banda Aceh, such as Lambaro Skip in Kuta Alam District and Tibang, Syiah Kuala district, only started in 1974.

Tambak establishment along the north-east coast grew rapidly in the late 1970s along with the development of semi-intensive shrimp farming (Figure 2). It evolved into the deliberate stocking of wild or hatchery fry in increasing densities supported by feed and water management inputs to increase yields. Three interesting points observed from *tambak* aquaculture development in Aceh province, specifically related to mangrove forests conversion:

- Mangrove forest conversion to *tambak* aquaculture took place more in the northern part of the East Coast of NAD province i.e. Banda Aceh and Aceh Besar. In Bireun, Pidie, North Aceh and Lhokseumawe, conversion to *tambak* was mainly from paddy fields (*sawah*), especially those close to the sea and estuaries.
- In Aceh extensive conversion of mangrove forest for shrimp farming began in the early 1960's when a Medan-based investor introduced a credit scheme for shrimp culture to groups of 40 farmers. Through a license (right to use/*surat izin menggarap*) issued by the village head (*keuchik*), those who did not have land could use any land available in the village to establish *tambak,* mostly by mangrove forest conversion. The shrimp culture that boomed in Southeast Asia between 1970 and the 1990s (Primavera, 1997) was a driving factor behind the development of brackish-water ponds in Aceh. They increased in area and more intensive technologies were adopted at the expense of mangrove forests being lost. This was also related to a technical recommendation made by a consultant of NAD Province Fishery Office, who stated that mangroves around the *tambak* can increase water acidity through their leaves and roots, which in turn decreases *tambak* productivity; especially shrimp aquaculture. In 1987, after more than ten years, the Fishery Office carried out mangrove reforestation, denying its previous technical recommendation.
- T*ambak* development in Aceh province (especially for shrimp aquaculture) reached its peak in 1995. Around 1995 shrimp diseases in the form of viruses, bacteria, and fungi caused major harvest failures. This was attributed to *tambak* pollution as a result of overexploitation. Many shrimp aquacultures were abandoned by the investor and. many farmers redirected their efforts into milkfish.

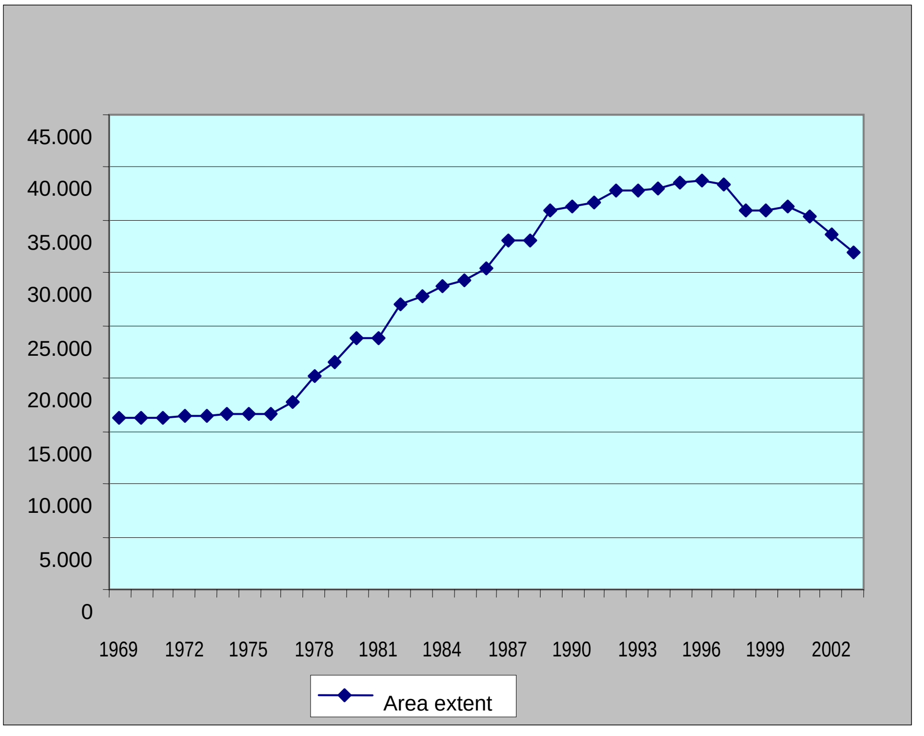


Figure 3. The development of *tambak* areas in NAD province, 1969 – 2003

In relation to technology, statistics on *tambak* aquaculture in NAD province in 2004 (BPS 2004), a year prior to the tsunami disaster, show that most of the *tambak* (75%) were operated traditionally with low production facility input, and shrimp and milkfish as the main output. The remainder were semi intensive *tambak* aquaculture (22%) mainly found in Biereun and Pidie, and only around 3% were intensive shrimp aquaculture *Tambak* aquaculture on the West coast of NAD province was initiated quite recently with a relatively small *tambak* area . Figure 3 shows the detail.

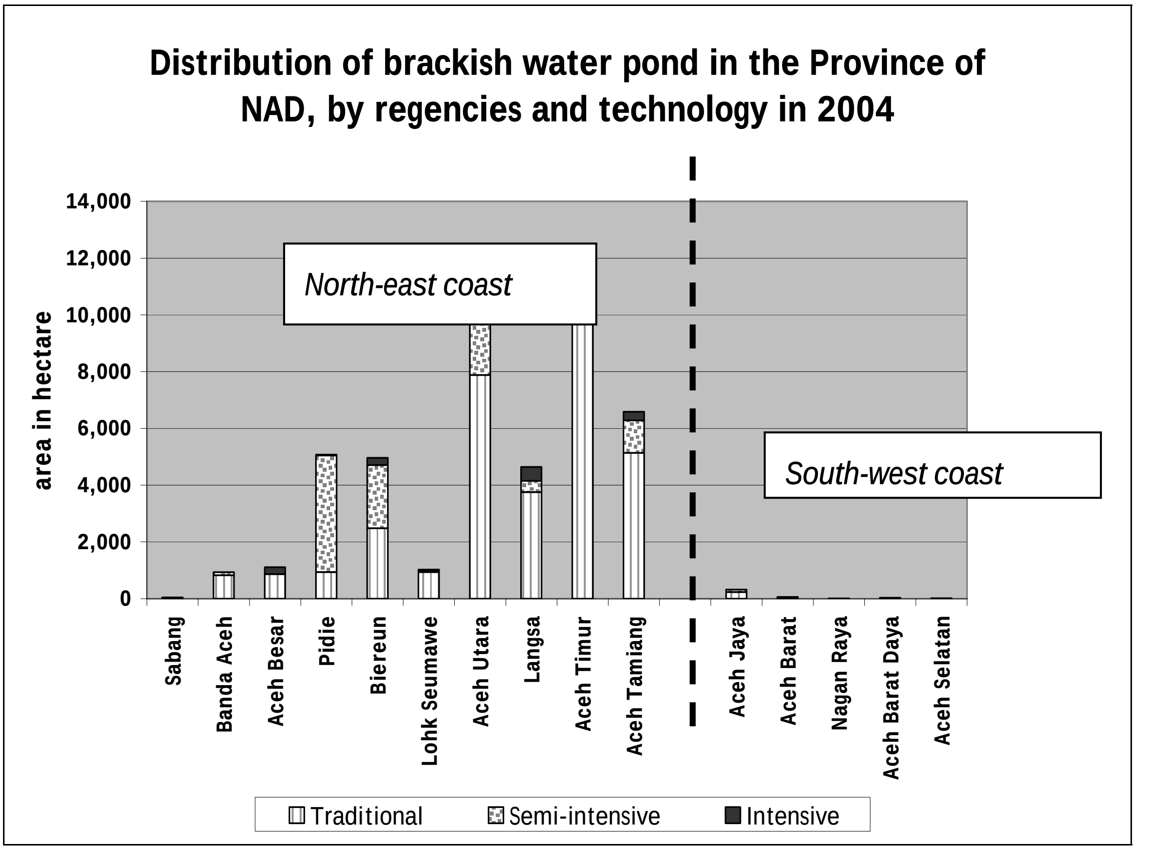


Figure 4. *Tambak* aquaculture distribution in NAD province, 2004, based on technology and Regency

2.2 Land holding, ownership and status

This section provides a **general overview** of legal aspects for lands utilized for *tambak* in the study site, related to land status and holding. Land status referred to here relates to land ownership based on the existing law (legal aspect), while 'land holding' refers more to the access[5] to land for *tambak* aquaculture. The words 'general overview' are highlighted to clarify that this subtopic is not an inventory of aquaculture land holding status. Instead it is aimed at providing a preliminary illustration of land status and holding for *tambak* aquaculture until present, thus giving a better comprehension of *tambak* aquaculture in NAD province. Information and data on land holding and ownership was collected through focus group discussions in 12 villages within the study site and records from the secondary data available at the provincial level (such as *Potensi Desa/PODES* statistics of NAD province) and at the village level.

Table 2 shows the *tambak* area of the selected villages in the study site and the number of *tambak* owners (regardless of *tambak* ownership status). The focus group discussions found that most of the *tambak* (70%) in the study site was land held and/or owned by the local people (meaning people residing in the same village as where the *tambak* is located) while the rest was

[5] The term 'access' used here means the ability to utilize the land (Reference: Ribot and Peluso: 2003), hereinwith used for *tambak* aquaculture

tambak owned by people outside the village, but still within the same *mukin*[6]. Note here that *tambak* ownership by people outside the village is solely related to migration due to marriage (following the spouse). Most of the *tambak* land is inherited. An interesting point is that the *tambak* area per family varies between 0.5 ha and 30 ha. The sizeable *tambak* areas are usually not self-managed.

Focus group discussions in the twelve selected villages indicated that not all *tambak* in the study site were established on privately owned land with secured land title (SHM). The land status of *tambak* in the study site consists of: *adat* owned land (80%); State-owned and (16%); *meunasah* land (tanah *wakaf*) (1%); and village public land (3%). Only approximately 5% of the *adat* land has a title certificate.

Table 2 *Tambak* area and *tambak* ownership area in the study site, by village

Sub district/Kecamatan	Village / Desa	Area (ha)	Numbe of owner (orang)	Average ownership
Kec. Syiah Kuala	Tibang	130	8	16.25
Kec. Kuta Alam	Lambaro Skip	150	70	2.14
Kec. Masjid Raya	Lamnga Gampong Baro Neuheun	192	96	2.00
Kec. Peukan Bada	Lam Tengoh	50	20	2.50
Kec. Kembang Tanjong	Lancang	216	178	1,22
Kec. Bandar Baro	Baroh Lancok	207	176	1,17
Kec. Samalanga	Meunasah Lancok	43	20	2,15
Kec. Jeunib	Teupin Keupula	85	46	1,85
Kec. Seunedon	Matang Lada	260	150	1,73
Kec. Blang Mangat	Kuala Meuraksa	100	70	1,43
		1,433	834	1.72

Based on land status data from PODES statistics 2003 (BPS, 2004), it is estimated that approximately 20% of *tambak* in the 12 selected villages were established on land which is not privately owned. Among those *tambak* on privately owned land, only 36.5% have title certificates; and mostly are located close to urban areas, such as Banda Aceh (Tibang and Lambaro Skip, 99.5% and 44.5% respectively), Pidie (Baroh Lancok, 43.9%). In rural areas, less than 10% of the privately owned land has title certification.

The use of *adat*/communal land for *tambak* is problematic. Firstly, prior to the 1960 Agrarian Law (UUPA) the land was owned by the local community. After UUPA 1960 came into effect, ownership acknowledgement issued by the Office of Land Affairs (*Badan Pertanahan Nasional/BPN*) was required, in line with Article 16 UUPA. However, until end of 2004 (before the tsunami), few *tambak* aquacultures were on traditionally-owned land with title; only 5%. Those people who settled on these lands are generally unable to show proper land history papers and legal title.

Secondly, legal status of *tambak* aquaculture land physically located on the seashore and/or riparian zone. Field observations and focus group discussions noted that several *tambak*

[6] *Mukim* is a settlement unit of the Aceh community local institution.

areas are located on, or within 100-150m from the coastline. The local traditional law stipulates that the ocean and beach (with sand) cannot be owned or become an individual entitlement but remains a public area. The local community calls it the *"luen pukat"* territory, i.e. the territory set one hundred fathoms from the highest rise of tide or 130 times the difference of the highest and lowest tide from the beach (approximately 150m from the beach). In Presidential Decree Number No. 32 of 1990 regarding protected zones, areas within a 100m radius of the highest tide towards the land, are public territory owned by the State. In reality, most of the land within these borders have been utilized for *tambak*.. This has been the condition for a long time, and even State-owned land has been repeatedly inherited. Most people who hold license (*surat izin menggarap*) issued by *keuchik* and who pay the land tax (PBB), feel that they have legal ownership over the land. This discrepancy occurs in almost all study site areas and therefore there is potential conflict over land rights in the future.

2.3 *Tambak* management and its social concern

Regardless of existing land status, like other agriculture practices in rural areas, the (*tambak*) land ownership influences the socio-economic status of the surrounding community. The study records 2,141 families (approximately 9,950 people) relying on *tambak* for their livelihood, covering 1,433 ha owned by 834 people. Figure 4 shows the detail.

Focus group discussions in the 12 villages of the study site identified that 408 (19%) heads of household (KK) work on land owned by another person with a profit sharing (*mawah*) system. Meanwhile there are 136 KK (6.4%) working as worker on land owned by another person as workers. This demonstrates that there is a social dimension to *tambak* management in the study site.

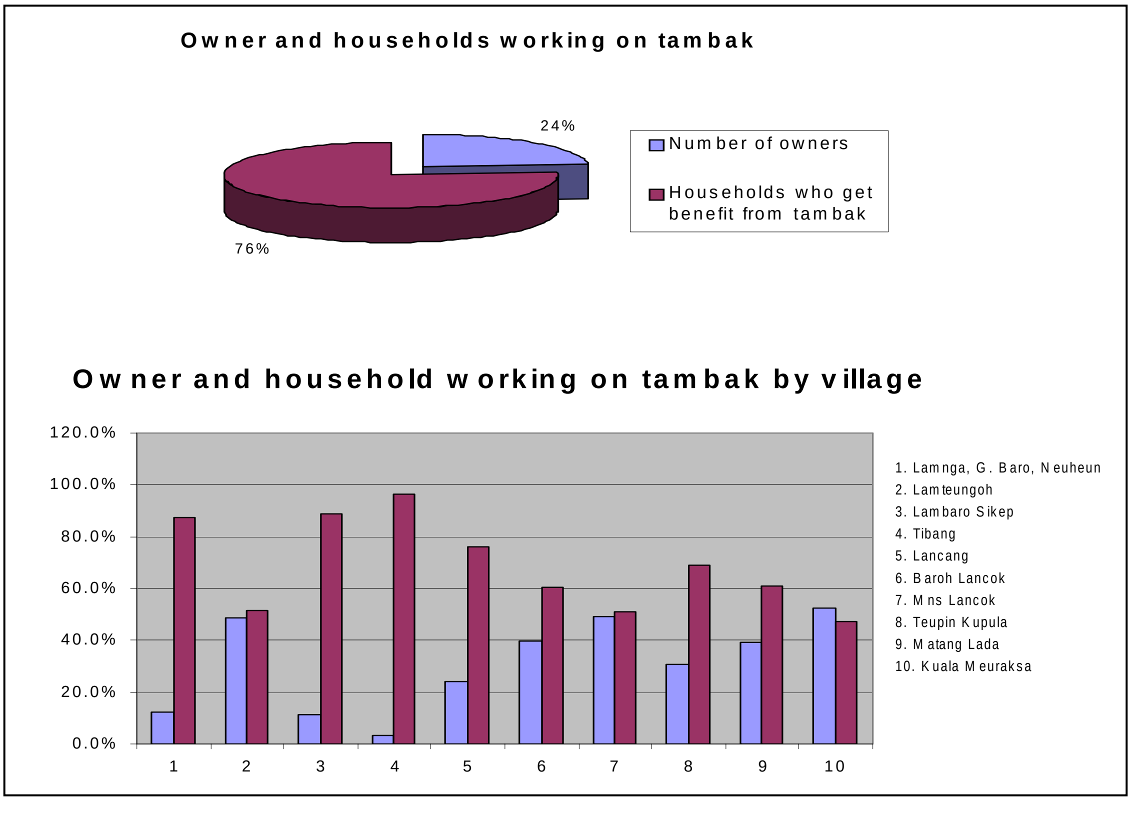


Figure 5. Proportion of *tambak* owner families against the people with livelihood from *tambak* aquaculture

There are two aspects from social perspective: needs to be considered in *tambak* aquaculture management i.e., (a) the parties involved; and (b) how *tambak* aquaculture is managed.

a. Parties involved in *tambak* management

There are four parties directly involved in *tambak* aquaculture management in the study site. These are the *tambak* owner, the financier, the *tambak* operator, and the worker/laborer. The owner is the person who owns the *tambak*, either residing inside or outside the village. The financiers are parties that provide funding to finance, partially or entirely, the working capital needed in *tambak* aquaculture. In local terms, this party is usually called *toke*, and plays significant role in the marketing chain of fishery businesses in rural areas. The *tambak* operator is the person managing the *tambak* aquaculture. It is common for the *tambak* operator to also be the owner. In many cases, the owner and manager have a profit sharing arrangement, locally called *mawah*, or a leasing arrangement. The workers are laborers involved in *tambak* aquaculture, either self-managed by the owner or managed under a *mawah* system. As workers, they receive wages (monthly or daily) or according to work packages. The relationship among parties in *tambak* aquaculture is extremely complex within the social system in Aceh. Figure 5 simplifies this relationship.

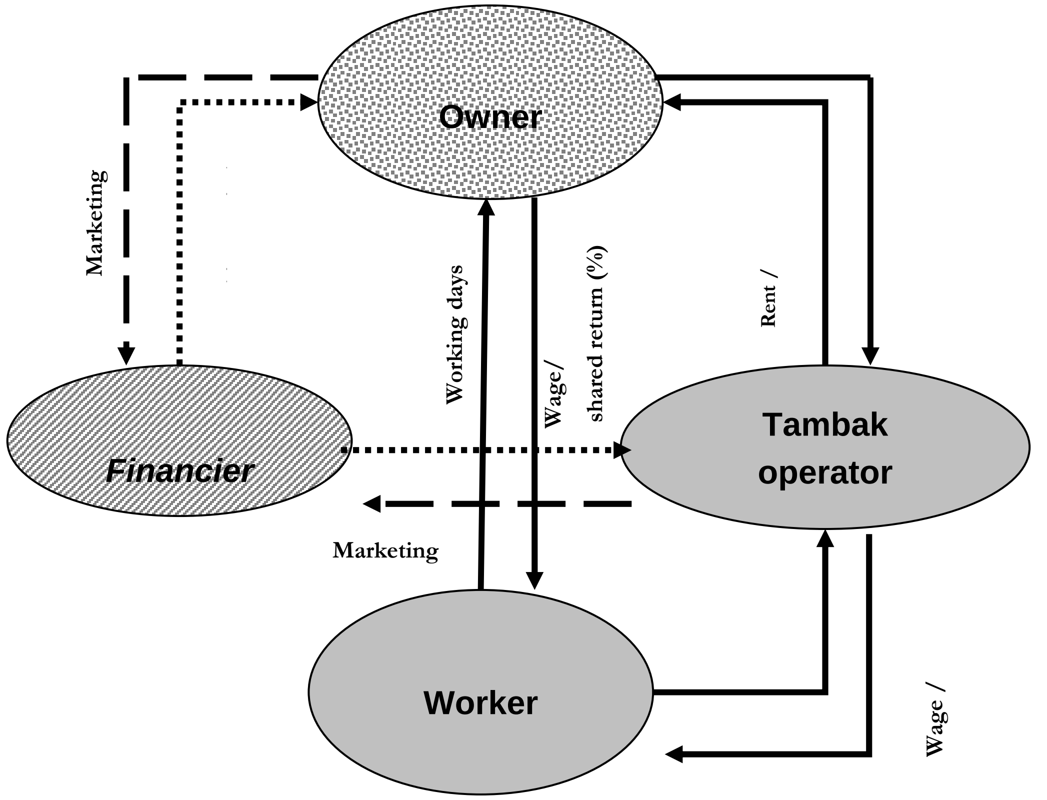


Figure 6. Relationship patterns among parties in the study site aquaculture

In *tambak* management, it is possible for the tambak owner, financier and operator to be the same person. This type of tambak management system is quite rare (see description of point 'b' below). Many *tambak* owners or *tambak* operators finance (partially or entirely) their working capital using loans from financiers, which are also the *toke*. The financiers (*toke*) do not impose interest rates on loans, but in return, the borrower must sell their harvest to the investor at a slightly lower price than the current market price, as well as returning the loan principal. The difference in price pre tsunami varied from Rp 1,000–Rp 2,000 per kilogram of harvest.

In cases where a *tambak* owner hands over his *tambak* to an operator under a profit sharing agreement (*mawah*), the operator will give a percentage of the profit to the owner, the ratio ranging from 1:4 to 2:3, provided the operator pays for all production costs. The proportion of profit sharing between operator and owner depends on mutual agreement, usually determined by soil fertility and location. If the operator receives credit (working capital) from the *toke* then the harvest must be sold to the *toke*. This sale is then distributed according to the agreement with the owner.

Tambak management by another party can also be done through leasing, where the owner no longer has access to his *tambak* during the lease period. The lease period can run for five to ten years, the price ranging from Rp 2million to Rp 10million per hectare annually, depending on soil fertility and location. This lease system is often practiced by investors from outside Aceh.

Financiers, who are generally also *toke*, play a significant role in smallholder *tambak* operation in Aceh. Although not all input costs are funded by the financiers, the *tambak* operator can request a loan at any time, providing the *toke* has the available funds. This loan process is very straightforward, based on trust and an agreement that the shrimp harvest will be sold to the *toke* as part of loan principal repayment. If the harvest is good, then the loan principal must be paid off, otherwise the loan can be paid in an instalment basis. If the harvest fails, such as occurred post tsunami, the loan repayment may be rescheduled. The working capital assistance from a financier can be in-kind (*tambak* aquaculture input) or cash, depending on the farmer's requirements. Cooperation between owner and/or manager and *toke* is not solely for operational costs associated with *tambak* aquaculture. Often a farmer will borrow cash for urgent domestic needs such as health, education or other daily needs.

b. *Tambak* management

Not all owners in the study site manage and/or operate their own *tambak*. Most of them handover the management and/or financing to another party. In relation to financing of working capital, land ownership and *tambak* operator, *tambak* management in Aceh can be categorized into five patterns:

1. The owner self-manages and self-finances his *tambak* using his own capital (owner = investor = manager).
2. The owner self-manages his *tambak*, but the working capital is financed, partially or entirely, by a financier (owner = manager ≠ investor).
3. The *tambak* owner hands over the management to another party, while the working capital requirement is financed, partially or entirely, by the proprietor (owner ≠ manager ≠ investor)
4. The *tambak* owner hands over management to another party under a profit sharing system and the manager self-finances his entire working capital (owner ≠ (manager = investor)).
5. The *tambak* owner self-finances the required working capital, however management of the *tambak* is entirely handed over to another party, with a profit sharing or wages system (owner = investor ≠ manager).

Figure 6 summarizes the *tambak* management pattern distribution in the study site, illustrating that patterns two and three (i.e. working capital finance relying on a proprietor) are the most dominant, covering 76% of *tambak* in the study site. Many of these are small-scale *tambak* owners (less than one hectare). The first pattern, where the owner self-finances and self-manages the *tambak* aquaculture, makes up the smallest proportion (4%). Statistics in the study site show that 408 (19%) KK work on other people's land under a profit sharing system (*mawah*) regardless of whether the working capital relies on a proprietor or is self-financed. There are 136 KK (6.4%) working on other people's land as *tambak* labor.

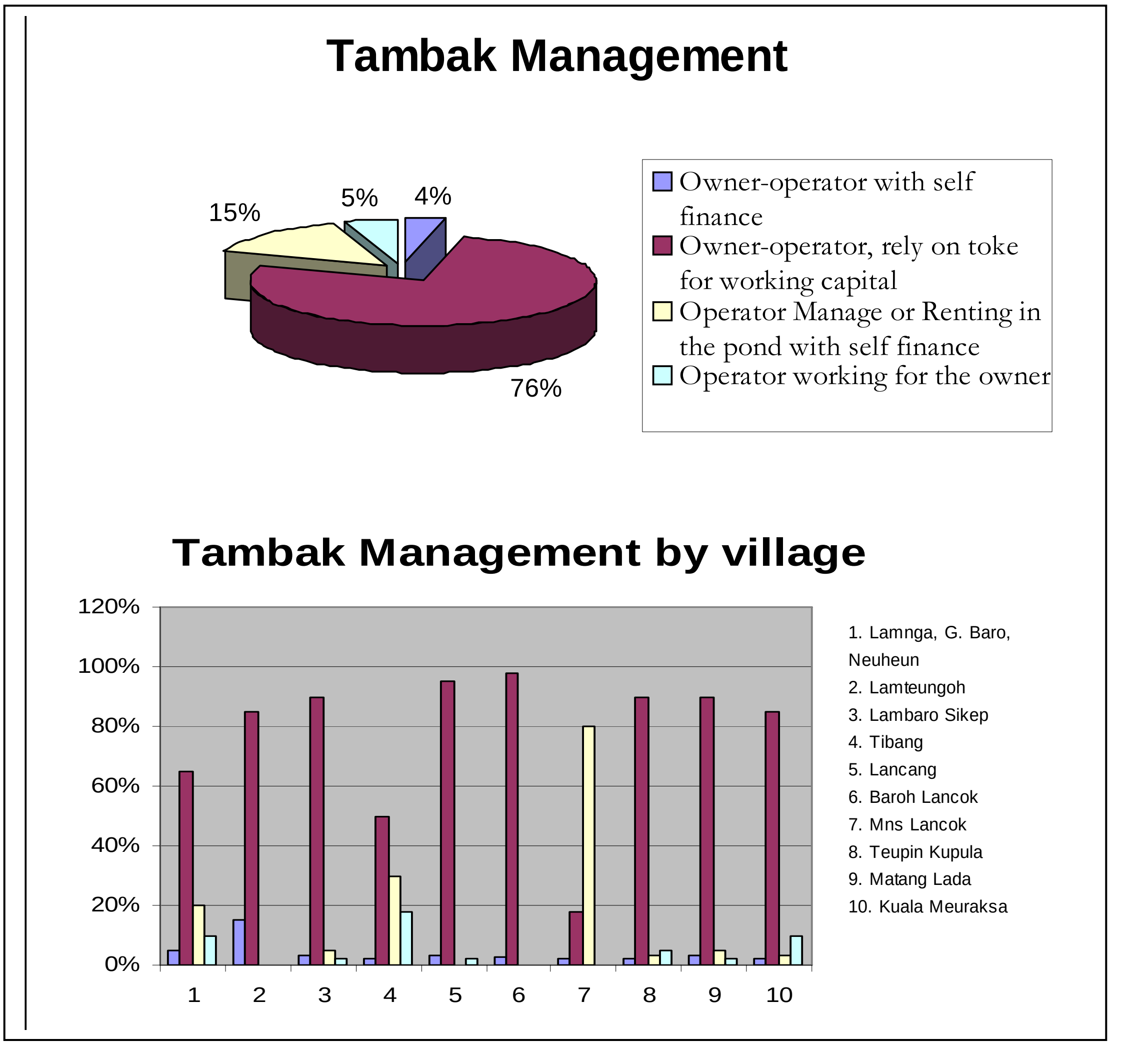


Figure 7 *Tambak* management patterns by village.

Existence of a *toke* (often seen as a negative party) and the *mawah* institution provides an opportunity for farmers with no land to operate *tambak* aquaculture. For example, in Tibang village, although the land for *tambak* is owned by a small group within the community, 85% of the village community's livelihood depends on *tambak* aquaculture in the village, primarily through laborers and managers working under the *mawah* system. This data indicates that the destruction of most of the *tambak* by the tsunami in Aceh not only impacts the land owner but also the entire society whose livelihood depends on the *tambak*.

2.4 *Tambak* Aquaculture System

The *tambak* aquaculture system in Aceh can be grouped according to technologies applied, including the rate of farm input and physical structures. Djuhriansyah and Abdusyahid (1999) categorized *tambak* aquaculture as primitive, traditional, semi intensive, or intensive based on shrimp fry resources and quality. In the primitive *tambak* aquaculture, the fry and hatchlings used are natural, taken from fry entering the *tambak* during the high tide. This primitive *tambak* aquaculture was only applied during initial development in Aceh and these are no longer used.

Observation and interviews with key informants and focus group discussions in the selected villages indicate that, in general, the *tambak* aquaculture system in NAD province can be categorized into three major groups: traditional, semi-intensive and intensive. The distinct difference between the three cultivation systems are: physical structure of the *tambak;* irrigation; amount of agricultural inputs such as stock density, feeding and fertilizer; and the amount of energy use for lighting and irrigation management. All these impact on the amount of capital required for *tambak* per hectare and the expected production output. Table 3 summarizes the general characteristics of the three *tambak* aquaculture systems in NAD province.

Table 3. General characteristics of the *tambak* aquaculture system in NAD province based on technology

	Traditional	**Semi-Intensive**	**Intensive**
Scale	0.5 ha – 5 ha	0.5 ha – 10 ha	5 ha – 50 ha
Lay out	Not orderly in layout; area per plot varies from 0.25 to 5 ha	Orderly design, area per plot varies from 0.5 to 5 ha.	Orderly design aiming at *tambak* management efficiency; area per plot varies from 0.1 to 1 ha
Irrigation	Only one water gate available; and it is used for both intake and drainage. Irrigation mainly relies on tidal water exchange	Each plot has separate intake and drain Irrigation still relies on tidal water exchange; also using water pump as necessary	Each plot hasseparate intake and drain Irrigation uses a water pump to manage water quality
Farming/ Production Cycle	4- 8 months per (1 or 2 harvests per year)	4- 8 months (1 or 2 harvests per year)	4 months (2 harvests per year)
Inputs			
1. Stocking – Shrimp fry	Freely from nature (rely on tidal water exchange) or bought from market Shrimp fry density varies from 1,000–20,000 per ha	Bought from reliable sources Shrimp fry density : 20,000-60,000 per ha	Bought from reliable sources with guaranteed fry quality Shrimp fry density: 100,000 - 600,000 per ha. Fry density between 100,000 and 200,000 per ha is the most common in Aceh.

	Traditional	Semi-Intensive	Intensive
– Milk-fish breeding stock	Collected from nature and/or bought from local market Stock density : 1,000-2,000 per ha	Breeding stock bought from reliable sources Stock density is no more than 2,000 per ha, as the focus is shrimp.	None
2. Feeding	Naturally growth algae (klekap) is the main feed. As necessary, farmers add rice bran and/or pellet (far below recommended dosages)	The first month feeding relies on naturally growth algae. The main feeding is rice bran and/or pellet, although not fully reaching the recommendations	Feed is given according to recommended dosage
3. Lighting	As necessary, farmers use kerosene pressure lantern (Petromax)	Kerosene pressure lantern and electricity from a generator	Electricity from generator or from public services (PLN)
4. Aerator	None; mainly rely on tidal water exchange	Aerator is used when needed	Always use aerator
Output and productivity	– White shrimp and/or tiger shrimp: 200– 00 kg/ha/production cycle – Milk fish: 200–300 kg/ha/production cycle	– Tiger shrimp: 600–800 kg/ha/production cycle – Milk fish: 150–300 kg/ha/production cycle	Tiger shrimp : 2,000–5,000 kg/ha/production cycle

Traditional *tambak* aquaculture, the main type practiced in NAD province (75% ; see point 2.1 and Figure 3 above) has numerous variations in terms of technologies applied and commodities produced. Some traditional *tambak* aquaculture concentrates on shrimp aquaculture using technology similar to a semi intensive *tambak* aquaculture system, however the stocking density remains within the traditional *tambak* aquaculture density limit. Aceh Besar Fishery Agency staff (personal communication) refers to this type of *tambak* as a **traditional plus *tambak*** aquaculture system. Further research is needed to discover the number of *tambak* farmers practicing this system.

Many *tambak* aquaculture operations with this traditional plus system rely on shrimp and milkfish commodities at the same time (polyculture). A polyculture option is solely aimed at reducing heavy losses in the event of a shrimp harvest failure, as can occur due to various reasons, mainly disease. Adopting a polyculture system is also related to limited capital. Parallel milkfish and shrimp cultivation is also aimed at improinge *tambak* water quality. Milkfish movements cause ripples, replacing the need for an aerator, especially during night time, and increasing the amount of dissolved oxygen in the water. Cultivating milkfish will also utilize excess natural food in an over fertile *tambak.* If silken moss is over-abundant in the *tambak*, the farmer adds milkfish to feed on, and reduce existing moss.

In Bireun, Lhok Semauwe and Aceh Utara, since 1990, grouper spawn aquaculture has been developed in traditional *tambak*, in response to requests by investors from outside the region (Medan and Banda Aceh). There are two types of grouper cultivated: tiger grouper and local grouper. In this case, the farmer's task is to grow grouper spawn to three inches within two months. For 10,000 grouper spawns, assuming a 30% mortality rate, and wages of Rp 25,000/person-day, the *tambak* farmer can obtain a net profit of Rp 4.5million for two months, or a return of Rp 61,500 per person-day. Grouper aquaculture can be carried out using *keramba* (netting in the *tambak*). The main obstacle is feed availability i.e. *rucah* fishes (various types of small fish caught in fishermen's nets, but not saleable for consumption). Initially the *rucah* fishes were returned to the ocean. However the growing need for these *rucah* fishes for grouper spawn aquaculture has triggered some reservations about the environmental impact of these catches.

In semi intensive systems, the farmer cultivates a combination of shrimp and milkfish (polyculture), although many farmers concentrate more on shrimp aquaculture. The density spread of Shrimp fry is 20,000–60,000 fry/ha/sowing season. The main shrimp feed in the first month originates from nature (*klekap*), and it is then replaced with external feed in the form of bran and/or pellets in subsequent months to increase shrimp growth. Intensive pest control is also carried out during the land preparation period, before spreading the fry. Water management (replacement) is also improved; utilizing water tides and as necessary a (mechanical) pump. The *tambak* farmers that apply this technology are farmers with sufficient capital or those willing to cooperate with the proprietors.

Intensive *tambak* aquaculture requires considerable capital for a water pump and mill, a good *tambak* construction with separate irrigation and drainage channels, electric lighting, high dosage feed provided regularly (1,500 gram feed for 1,000g of shrimp). The location of *tambak* within an intensive aquaculture system depends on efficiency in irrigation management, mobilizing labuor for supervision and providing feed, and harvest transportation. *Tambak* partitions are generally relatively small, each between 0.10–1.0ha. Feed is entirely dependent on pellets provided at an ideal composition for shrimp growth with a 1:2 ratio, meaning that to produce 1 ton of shrimp, 2 tons of feed is required. A mill that acts as an aerator to add oxygen to the water must be installed. Water replacement is carried out using a pump, relatively often, ensuring water quality. Water quality is examined thoroughly.

Production in an intensive *tambak* aquaculture system, concentrating on superior quality shrimp, is relatively high, up to 30 tons per hectare annually. The average production of an intensive *tambak* aquaculture system in Aceh varies from 10–20 tons/ha/year; lower than Japan, Taiwan, and Thailand which can reach 60 tons/ha/year.

The number of intensive *tambak* aquaculture systems is limited and most are run by investors from outside Aceh province (Medan, Jakarta as well as other countries in Asia). Usually the investors rent local community-owned land for a period of 5 to 10 years with *tambak* land rent varying from Rp. 2 million to 10 million/ha/year, depending on the level of fertility and location. In focus group discussions with *tambak* farmers in the 12 selected villages, several issues regarding intensive *tambak* aquaculture practices were noted.

First, the environmental aspects. *Tambak* land cultivated intensively, generally for four consecutive years, cannot immediately be used for *tambak* aquaculture; but must be 'lain' for one or two years. This may be related to over usage of pesticides, fertilizer and feed. Second, the social relations aspect. Investors usually hire labor brought with them; not from the local community. This often brings about jealousy amongst the surrounding community, especially if the labor force conflict with local customs in regard to harvesting systems. One local custom, mentioned by a focus group participant, is that during the harvest season there is a period when all of the community around the *tambak* is allowed to participate in harvesting, compensated by a kilogram of shrimp per person.

2.5 Production

Tambak aquaculture is essentially the activity of nurturing and growing marine biota in a brackish pond within a certain period of time to obtain a product through harvest (Directorate General for Fishery Aquaculture, 2002). The type of marine biota cultivated in the *tambak* at the study site include: tiger shrimp (*Penaeus monodon*); white shrimp (*Penaeus merguensis*); milkfish (*Chanos chanos*); snapper (*Lates calcalifer*);tiger grouper (*Epinephelus fuscoguttatus*); and mud grouper (*Epinephelus lanceolatus*). *Tambak* farmers mostly cultivate **tiger shrimp** (*Penaeus monodon*) due to its relatively high sale price and its high demand by overseas markets (export). M**ilkfish** (*Chanos chanos*) are also commonly grown by *tambak* farmers.

Shrimp is the main commodity in *tambak* aquaculture of NAD province (Table 4.) Fishery statistics of 2003 show that shrimp is the major aquaculture commodity in NAD province (78%) as well as the study site (71%). This is understandable because shrimp have a broader market (export) whereas white shrimp and milkfish have a relatively limited market. Data in Table 4. shows that 52% of the total *tambak* production of NAD province originates from this study site.

Table 4. *Tambak* aquaculture commodity in NAD province and Study Site for 2003.

Commodities	NAD Province		The study site	
	(ton)	%	(ton)	%
Tiger shrimp	8,487.1	(77.2%)	4,091.6	(71.2%)
White shrimp	1,066.7	(9.7%)	1,014.9	(17.7%)
Milk fish	1,445.5	(13.1%)	639.3	(11.1%)
Jumlah	10,999.3	(100%)	5,745.8	(100%)

Source: Dinas Perikanan

Milkfish aquaculture is familiar to *tambak* farmers and was previously a superior product. However, since widespread introduction of superior shrimp aquaculture species (prawn) in the 1960s, milkfish have become an alternative commodity in *tambak* aquaculture, especially after a shrimp aquaculture disease attack in the mid 1990s. The milkfish commodity option is reasonable due to:(1) milkfish fry growing and germination technology is well-practiced and developed in the community; (2) milkfish livelihood requirements are simple and they are tolerant to environmental changes; (3) the milkfish market has been developed; and (5) milkfish have a relatively high selling price, second after shrimp. Bireun and Aceh Utara are milkfish production areas in NAD province. Of the 639.30 tons of milkfish produced in the study site in 2003 most (84.66%) comes from *tambak* aquaculture in Bireuen and Aceh Utara Regency. Meanwhile, Aceh Besar regency contributes 10.34%. The remaining comes from Pidie (4.94%) and Banda Aceh Regency (less than 1%).

White shrimp remain a side-product of *tambak* aquaculture (using traditional and semi intensive technology). White shrimp fry enter the *tambak* with the rise of tide at the time of *tambak* water management. Some of the white shrimp entering with the tide are ready for harvest (mature shrimp) and some still need to grow for 1–2 months to reach harvest size but they do not require additional feeding. Most of the traditional *tambak* farmers who lack adequate capital are located along the Aceh East coast and rely on abundant white shrimp production. With an aquaculture period of 2–3 months (4-5 harvests annually), and 10g/shrimp, production can reach 200–300 kg/ha/harvest with annual production reaching 1,000 kg/ha annually. Assuming the price of white shrimp is Rp 20,000 per kg (price at the time of field observation; December 2005) the farmer will receive a gross income of Rp 20 million/ha/year.

2.6 Capital

Excluding large scale and capital intensive *tambak* aquaculture, many *tambak* farmers in the study site (92%) finance their capital with assistance from financiers. Few finance the capital themselves. It needs to be noted that ***tambak* farmers never apply for credit from a bank or receive credit loans from the government**. This relates to existing social structures within Aceh society.

As mentioned above, financier's flexibility in providing funds for *tambak* farmers are their advantage. The social capital of trust between *tambak* farmers and proprietor ensure their cooperation. Financiers do not just provide funding for the farmer's working capital, but also for urgent household requirements. The loan can be in-kind or cash. As compensation, the farmer must 'sell' their product to the proprietor. The loan repayment amount depends on harvest sales value. If the harvest is not profitable, the *tambak* farmer can delay payment or credit.

2.7 Marketing: tiger shrimp

Tiger shrimp has its own marketing chain as it is more export oriented rather than grown for the domestic market. Figure 7 is a general illustration of the shrimp marketing chain in Aceh. There are three possible marketing chains the farmer can select. However, for farmers receiving capital assistance from a *toke*, the marketing will be determined by the *toke*, depending on their business position. Only farmers who self-finance their *tambak* have the three options. Excluding those around Banda Aceh, the general marketing chain practiced by farmers (and proprietors) is marketing channel 1. For Banda Aceh, channel 2 is more often uses. Marketing channel 3 only occurs with low grade shrimp commodity, such as white shrimp or small shrimp.

Disregarding which marketing channel the *tambak* farmer practices in selling their shrimp product, the producer has the highest profit margin, followed by wholesaler /exporter, usually located in Medan. Table 4 illustrates a simple profit margin calculation for each marketing chain per kg of shrimp. The *tambak* farmer's profit margin is 27.9% of the final consumer sale price ($10 = Rp. 90,000) per kg of shrimp. Meanwhile, the wholesaler or exporter's profit margin is 13.33%. The profit received by village, district and municipality traders is less than 2%. It is easy to see from this calculation, why many proprietors are willing to borrow to *tambak* farmers. The 27.9% profit margin is insurance for return of capital.

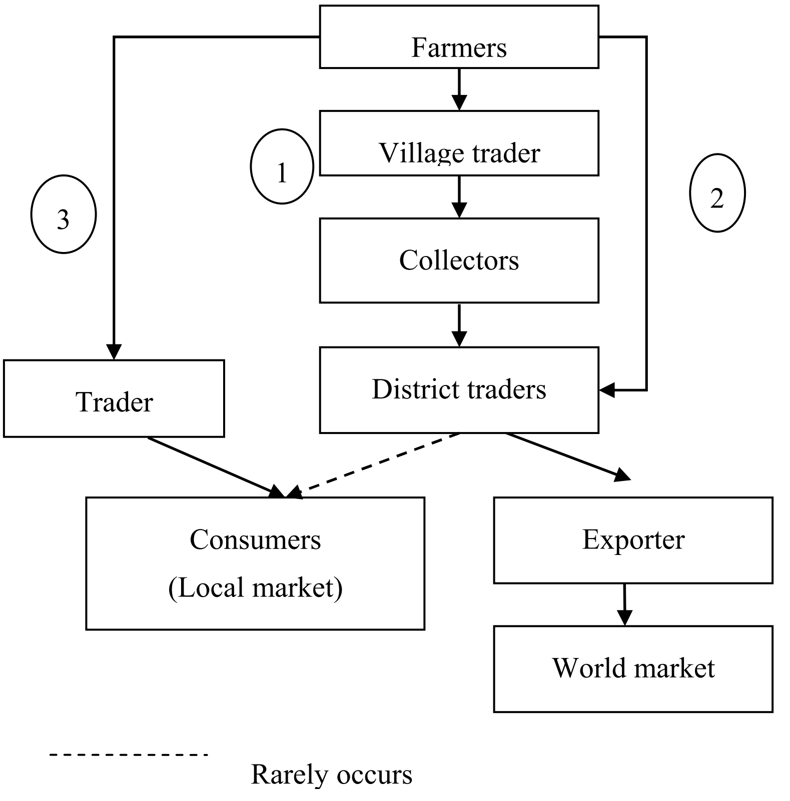


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Figure 8 Shrimp marketing chain in the study site

Table 5 Shrimp marketing margin at the study site

	Value (Rp.)	Nilai (Rp/kg.)	(%) of export price
1. Selling price at farmgate (30 shrimp/kg)		60,000	66.67
a. Cost of production (Rp/kg)	34,886		38.76
Profit margin for farmer (1-a)		**25,114**	27.90
2. Buying price from farmers (Rp/kg)		60.000	66.67
a. Basket (Rp/kg)	2,5		0.00
b. Packaging (Rp/kg)	50		0.06
c. Transportation (Rp/kg)	200		0.22
d. Miscellaneous (Rp/kg)	25		0.03
e. Selling price at village trader (Rp/kg)		61,000	67.78
Profit margin of village trader (e-2-a-b-c-d)		**723**	0.80
3. Buying price from village trader (Rp/kg)		61,000	67.78
a. Basket (Rp/kg)	0		0.00
b. Packaging (Rp/kg)	50		0.06
c. Transportation (Rp/kg)	250		0.28
d. Miscellaneous (Rp/kg)	50		0.06
e. Selling price at collector (Rp/kg)		62,000	68.89
Profit margin of collector (e-3-a-b-c-d)		**650**	0.72
4. Buying price from collectors (agent)		62,000	68.89
a) Packaging (Rp/kg)	100		0.11
b) Transportation (Rp/kg)	1,000		1.11
c) Miscellaneous (Rp/kg)	300		0.33
d) Selling price at district trader (Rp/kg)		65,000	0.00
Profit margin district trader / agent (e-4-a-b-c-d)		**1,600**	1.78
5. Buying price from district trader /agent		65,000	72.22
a) Packaging (Rp/kg)	1,000		1.11
b) Transportation (Rp/kg)	10,000		11.11
c) Miscellaneous (Rp/kg)	2,.000		2.22
d) Selling price at exporter in Medan (US$ 1 = Rp 9,000)	$ 10	90,000	100.00
Profit margin of exporter in Medan (e-5-a-b-c-d)		**12,000**	13.33

3. Tambak Aquaculture Financial Analysis

This chapter aims to provide a general illustration of the capacity of *tambak* aquaculture to generate financial benefit for *tambak* farmers and economic benefit for the environment using simple farm budget analysis. Specifically this review is expected to determine:

(1) land productivity for *tambak* aquaculture (using various existing technologies) measured from land profitability by calculating the *tambak* aquaculture Net Present Value(NPV);

(2) *tambak* capacity in generating profit for farmers, measured by calculating the net revenue per person-day;

(3) capacity of a *tambak* area to provide job opportunities in rural areas, measured by calculating labor requirements per hectare per year; and

(4) the amount of investment required.

3.1 Measuring *Tambak* Aquaculture Profitability

Profitability, or the capacity to generate financial and economic profit for an agriculture activity (i.e. *tambak* aquaculture), has two perspectives. First, land profitability, i.e. how much does the land–use activity generate profit financially and economically? Here, profitability is measured by calculating the Net Present Value (NPV), i.e. the difference between present value of benefit/revenue and present value of costs during a certain time period at a set interest rate (Gitinger, 1982 p. 319). Mathematically it is formulated as follows:

$$NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

where B_t is the benefit value at t and C_t is the cost at year t. Meanwhile, is the discount rate used. A positive NPV shows that the investment activity is sufficiently profitable. A negative NPV does not necessarily mean the relevant business investment activity is non profitable, it merely indicates that the existing resources can be better allocated to another investment activity.

Second, profitability for the farmer. This is measured by observing the returns on labor (wage revenue per person-day) calculated by changing the existing 'surplus' into wage per person day (Vosti etal, 1998: 13). Technically, the calculation is done by changing the wage rate in the farm budget analysis in such a way that NPV = 0. Returns on labor, calculated with financial price, are the farmer's production incentive indicator; measuring the amount of incentive capacity generated by an agriculture system during production for the farmer. A return on labor lower than the average wage indicates that the relevant investment activity is an attraction for farmers to manage.

3.2 *Tambak* Aquaculture budget analysis

Financial analysis of *Tambak* aquaculture will be carried out using farm budget analysis. The following t*ambak* aquaculture budget analysis calculation at the study site is categorized into four management patterns based on technology: traditional; traditional plus; semi intensive; and intensive.

The *tambak* aquaculture budget analysis uses a 10 year production scenario with assumptions stated in the following three tables. Table 5 summarizes the main components of *tambak* aquaculture external inputs. This table illustrates the difference in input levels from the four existing technologies. Table 6 summarizes annual *tambak* aquaculture production and effective production across the four patterns of *tambak* management within the duration of this analysis (10 years). The macro-economic assumption and *tambak* production price used in this analysis is presented in Table 7.

Table 6 External farm input components of brackish water pond aquaculture

Items	Unit of measurement	Technology and economic of scale			
		Intensive	Semi-Intensive	Traditional Plus	Traditional
		(2< ha)	(2-5 ha)	(1-2 ha)	<2 ha
Electricity/ power generator	Unit/farm	A must, with minimum capacity of 5800 AC/W	A must, with minimum capacity of 2900 AC/W	A must, with minimum capacity of 1000 AC/W	Not necessary
Water pump		A must	A must	A must	No need
Aerator		A must	A must	YES and NO	No
Electrical installation		10	2	No	No
Simple canoe		2	1	No	No
Tools					
– Salinomater		A must, at least 1 unit			
– pH meter		A must, at least 1 unit	A must, at least 1 unit	Necessary	Not available
– Harvesting net	Unit	20	4	2	2
– Container	Unit/ha	20	5	2	2
– Jerry can	Unit/ha	5	2	1	1
– Petromax	Unit/ha			2	2
Seed stocking					
– Shrimp fry	head/ha/ year	280,000	120,000	50,000	up to 40,000
– Fingerling (of milk fish)	head/ha/ year			4,000	3,000
Chemicals					
Agricultural lime	kg/ha/year	1000	1000	1000	1000
Insecticides					
– Thiodan ®	ltr/ha/year	4	4	3	2
– Dursban ®	ltr/ha/year	6	6	4	3
– Bristan	kg/ha/year	1	1	1	0
Fertilizers					

Items	Unit of measurement	Technology and economic of scale			
		Intensive	Semi-Intensive	Traditional Plus	Traditional
		(2< ha)	(2-5 ha)	(1-2 ha)	<2 ha
– Urea	kg/ha/year	700	600	400	400
– TSP	kg/ha/year	500	400	200	200
Feed	kg/ha/year	8400	3600	1000	600
Employees					
Technician	ps-m/ha/year	1			
Operator	ps-m/ha/year	5	1	2	2
Night guard	ps-m/ha/year	3	2		

Table 7 *Tambak* production assumptions

Items	Unit of measurement	Technology and economic of scale			
		Intensive	Semi-Intensive	Traditional Plus	Traditional
		2< ha	2-5 ha	1-2 ha	<2 ha
Operation		10 year production cycle with fallow rotation	10 year production cycle with continuous cultivation	10 year production cycle with continuous cultivation	10 year production cycle with, continuous cultivation
Brood stock density					
Tiger shrimp	head/ha/year	280,000	120,000	50,000	40,000
Milk fish	head/ha/year			4,000	3,000
Survival rate					
Tiger shrimp	%	50.0%	50.0%	48.0%	48.0%
Milk fish	%			60.0%	60.0%
Production (kg/ha/year)					
Tiger shrimp					
Size C (40 tail/kg)	kg	1,120	720	360	336
Size B (30 tail/kg)	kg	2,333	800	256	160
Size A (20 tail/kg)	kg	1,260	360	96	48
		4,713	1,880	712	544
Milk fish	kg	0	0	800	600
White shrimp & other	kg	80	80	80	80
Capital					
Investment on tambak construction and its infrastructure	Rp 000/ha	47,613	44,183	18,905	17,915
Working capital	Rp 000/ha	65,392	37,895	16,172	11,289

Table 8 Macro-economic parameters and prices (of tambak commodities) used in the assessment.

Exchange rate December 2005 (Rp / US $)	9,100
Agricultural wage rate (Rp/person-days)*	35,000
Discount rate **	15%
Tambak's commodities prices	
1. Tiger shrimp	
Size A (Rp/kg)	75,000
Size B (Rp/kg)	60,000
Size C (Rp/kg)	50,000
2. Milk fish (Rp/kg)	12,000
3. White shrimp (Rp/kg)	20,00

Note:

*) Wages in rural areas at the time of this study reflect an abnormal condition, where massive recovery and reconstruction activities post tsunami were carried out, driving rural labor wages to Rp. 50,000 per person day. The wage rate used in this study is Rp 35,000 per person day, bearing in mind that condition.

**) The discount rate refers to the real interest loan rate – net of inflation. A discount rate of 15% is a conservative estimate based on field facts where the loan interest rate ranges from 20–35%. Assuming the inflation rate in Aceh ranges from 5-20%, a 15% discount rate is a prudent assumption.

Using the above assumptions (input, production and macro economic parameters), the calculated and summarized *tambak* aquaculture budget analysis for the study site is presented in Table 8.

The *tambak* aquaculture budget analysis demonstrates that the application of more intensive technology requires intensive capital and tends to result in a more advantageous outcome financially. For the proportion of expenditure, the external farm input and labor component are significant for all patterns. Calculations based on farm machinery utilization show that more intensive technology implies a rise in cost.

Table 9 Discounted Farm Budget (r=15%) of Brackish water aquaculture in Aceh (10 year production scenario) per hectare, in Rp 000

	Intensive	Semi-Intensive	Traditional Plus	Traditional
Revenue	868,271	418,520	225,888	169,329
Expenditure				
1. Physical investment	52,231	52,231	22,264	22,264
2. Tradeable				
• External farm input	187,387	110,466	76,329	50,450
• Tools	9,111	10,033	6,528	4,736
• Farm machinery (cost of machine-hours used)	84,828	72,370	13,410	0
3. Labor				
• Tambak construction	21,902	5,723	7,401	6,997
• Infrastructure maintenance	3,745	4,683	5,499	5,499
• Land preparation	14,357	17,953	21,079	15,580
• Shrimp and fish culture	45,658	48,840	46,522	43,249
• Permanent skilled labor	44,387	10,505	0	0
Total expenditure	463,606	332,805	199,031	148,774

3.3 Cost of Establishment and Profitability

Table 9 presents the initial capital requirement and profitability of the four *tambak* aquaculture types in the study area. The initial capital requirement per hectare is smaller for traditional and traditional plus types of *tambak* compared to *tambak* with more intensive technology. A significant difference is the working capital requirement; where intensive technology *tambak* requires much higher working capital than the three other types. From the initial capital required, many people conclude that only major investors from outside Aceh can afford to manage the *tambak* intensively. This view is not entirely accurate, because the main obstacle in adopting *tambak* aquaculture technology lies in the technical know-how which ha not yet been mastered by the Aceh *tambak* farmers. Although intensive shrimp *tambak* aquaculture has been operating in this province since the mid 1980s, the aquaculture technical know-how has not been easily adopted by the community. Many investors bring in their own key experts leading to social problems. Therefore, aside from limited capital for intensive *tambak* aquaculture, technical know-how, is also a major obstacle in applying the intensive aquaculture system.

Table 10 Capital and profitability of brackish water aquaculture

		Intensive	Semi-Intensive	Traditional Plus	Traditional
Initial capital	Rp 000 ha^{-1}	47,613	44,183	18,905	17,915
Working capital needed	Rp 000 ha^{-1}	65,392	37,895	16,172	11,289
		113,005	82,079	35,076	29,203
Returns to land					
NPV (10 year tambak operation)	Rp (000)ha^{-1}	404,666	85,716	26,857	20,555
Returns to labor	Rp/ps-day	244,649	74,529	46,332	44,802

For traditional aquaculture, the capital requirement is approximately Rp 30 million. In normal conditions, most of *tambak* farmers in NAD province can afford the capital, through self-financing and proprietor aid. However, post tsunami conditions make it unaffordable as the *tambak* community no longer has the financial capital required.

From a profitability perspective, intensive *tambak* aquaculture generates the highest profit. Calculations using prices in December 2005 show that more intensive *tambak* aquaculture has a higher profitability capacity. However, prudence is necessary in interpreting these results. The financial profitability estimates still exclude: the social costs of losing mangrove areas for *tambak* aquaculture; the environmental and social damage, such as water pollution, health, and salinity due to intensive *tambak* aquaculture; and the diminishing fish population due to disappearance of the natural spawning area. Many social values in local institutional and communal ownership are in conflict with existing intensive *tambak* aquaculture which is managed privately.

The high profit of intensive *tambak* aquaculture in NAD province attracts many investors from outside Aceh. It should be noted that intensive *tambak* aquaculture in NAD province is extremely dynamic in terms of size and location. Often intensive *tambak* aquaculture operations suddenly cease after two or three years of business and move to another location for security reasons (socio-political issues) or because of deterioration of the *tambak* productivity related to water quality or pollution of the land by chemical substances used in intensive *tambak* aquaculture.

3.4 Job Opportunities

Generally speaking, job opportunities are the labor requirements in a production system. This review found that *tambak* aquaculture requires more labor compared to other agricultural activities. Table 11 shows how *tambak* aquaculture labor varies from 392–739 person-days/ha/year depending on the type of technology being used. For intensive *tambak* aquaculture, professional staff are required as technicians at approximately two man months /ha/year.

During the *tambak* construction phase, labor requirements vary from 99-196 person-days/ha, from menial labor through to technicians. *Tambak* construction for intensive and semi intensive use is carried out using back-hoe equipment that requires good positioning. These two types of *tambak* require professional labor to design the *tambak* position and back-hoe operators, estimated at nine person-days/ha of *tambak*. As a comparison, labor requirements in paddy agriculture relying on rainfall is approximately 179.4 person-days/ha/year and in an irrigation paddy, 238.3 person-days/ha/year.

Table 11 Labor requirements for brackish water aquaculture by technology

	Unit	Intensive	Semi-Intensive	Traditional Plus	Traditional
Tambak establishment					
• profesional labor (back-hoe operator)	ps-d/ha	9	9	0	0
• skilled labor	ps-d/ha	155	65	48	48
• unskilled labor	ps-d/ha	32	25	96	96
		196	99	144	144
Operational					
• profesional labor (management & technician)	ps-m/ha/year	2	0	0	0
• skilled labor	ps-d/ha/year	349	109	10	6
• unskilled labor	ps-d/ha/year	390	412	489	386
		739	521	499	392

From the perspective of revenue per person-day, *tambak* aquaculture can better compensate labor than other types of agricultural production. The calculations in Table 11 show the main *tambak* aquaculture managed in the study area, i.e. traditional and traditional plus, have *returns to labor* of around Rp 46,000 per person-days; higher than the average agriculture wage at the time (Rp 35,000 per person-days). Compared to catchment fishing the per person-day revenue for *tambak* aquaculture remains higher. In normal conditions, a boat attendant's average wage, usually paid based on the amount of fish caught, varies from Rp. 29,500 to Rp 39,500 per person-days, depending on the fish catchments business.

The above illustrates that *tambak* aquaculture provides job opportunities in rural areas; up to 392– 39 person-days/ha/year. If one village has 100 ha of *tambak* area, than the amount of labor that can be accommodated in *tambak* aquaculture varies from 39,200 person-days to 70,390 person-days /year. Assuming that the number of effective work days in a year is 259, the *tambak* aquaculture sector can provides jobs for approximately 153–272 farmers (head of households) or 15–27 jobs per 10 ha.

The issue becomes what if the labor requirements are not fulfilled by working class in the local village? This is the situation which occurred in the region post tsunami. If all *tambak* aquaculture businesses were concurrently rehabilitated and immediately operational, a rise in labor requirements would occur and eventually increase the labor wage. In fact, at the time of this study, labor wage had increased significantly in the regions impacted by the tsunami. This is due to massive rehabilitation efforts post disaster by several donor agencies. This issue will be elaborated on in detail in the following chapter.

4. Tambak Post Tsunami and Rehabilitation Efforts

The condition of *Tambak* aquaculture in NAD province post tsunami disaster of 26 December, 2004 is of great concern. The damage was not just limited to the physical *tambak,* but *tambak* farmers owning land within the tsunami zone lost their livelihood and also their working capital. This seriously impacted on the availability of community financial capital, including proprietor (*toke*) capital which is the main provider of work capital and marketing services for *tambak* farmers. The hopes of proprietors for a profit from the harvest were shattered along with the wrecked *tambak*, and the capital loaned to the farmers will not be returned in the near future, if ever, due to the disaster.

The damage caused to the *tambak* aquaculture system due to the tsunami disaster in NAD province and *tambak* rehabilitation efforts are illustrated below, based on existing field data. Aside from presenting *tambak* rehabilitation efforts, this study attempts to carry out a financial analysis (ex-ante analysis) of rehabilitation activities.

4.1 Physical Damage ad Financial Loss

The tsunami impact analysis report by FAO (Philip and Budiman, 2005) estimates 43% of *tambak* area in NAD province was destroyed by the tsunami wave (Table 12). Most of the damage occurred in the study area[7]; 15,087 ha of the total 20,428 ha. The monetary value of damage to the study area is estimated at Rp 331 billion (DKP, 2005)

The physical damage to *Tambak* not only caused the loss of livelihood (production), but also loss of farmer working capital. Financial capital available in the community was greatly reduced, including proprietor capital which is the main provider of working capital and marketing services for several *tambak* farmers.

A review carried out by the Department of Marine and Fishery estimates that the financial loss in the study area due to the tsunami reached Rp 1,061.7 billion consisting of working capital loss value of Rp. 561.3 billion and production loss of-+ Rp. 500.4 billion.

[7] The selected study area is Banda Aceh Municipality, Aceh Besar Regency, Pidie Regency, Bireun Regency, Aceh Utara Regency and Lhok Seumawe Municipality

Table 12. *Tambak* damage level estimates (in hectares) at NAD province and study area.

Description	NAD province	Study area1
Tambak size prior tsunami [1)]	47,620.7 ha	23,562.8 ha (49.5%)
Damage due to tsunami		
- Minor	14.5%	21.9%
- Medium	10.9%	15.5%
- Severe	15.4%	23.6%
- Lost	2.1%	3.0%
Total damage	20,428.2 (42.9%)	15,086.7 (64.0%)
Not damaged	57.1%	36.0%
Physical damage value [2)]		Rp 331.7 billion

Source :

1) Philip and Budiman, 2005. An assessment of the impacts of the 26th December 2004 earthquake and tsunami on aquaculture in the Provinces of Aceh and North Sumatra, Indonesia. Jakarta. FAO
2) Dept. of Marine and Fishery. 2005. Rehabilitation and Reconstruction Plan in NAD province and North Sumatera Post Tsunami, Marine and Fishery Sector. Jakarta

4.2 Post Tsunami Marketing Institution

As described above, there are generally three marketing channels used by *tambak* farmers. These channels involve the village trader (*muge*), collector trader (usually at district level), wholesaler (agent), retailer and exporter from Medan (see point 2.7). All of these marketing agents act as capital providers (*toke*) and have a solid institutional network in their respective group. For example, an exporter in Medan collaborates with their own *tambak* product suppliers within their business group, consisting of a wholesaler and collector traders. Similarly, the wholesaler and collector traders in the municipality and regency also have their own business group. This business network is bound by the *tambak* product marketing system and an informal credit system based on a long established trust.

The tsunami wave which destroyed most of the *tambak* aquaculture in NAD province also shook the foundations of the *tambak* aquaculture business network. The existing institutions failed to function properly. The other main issue is the major loss of financial capital. Proprietors lost their capital, because the working capital lent to farmers disappeared with the tsunami wave. *Tambak* farmers who lost all their production capacity are having difficulty obtaining working capital for *tambak* rehabilitation.

Rehabilitation in NAD province will not be achieved without capital assistance from outside organizations. Marketing institutions can only function if the *tambak* production system is reactivated and operational.

4.4 Tambak Rehabilitation Efforts

Self-rehabilitation of *tambak*, individually or collectively, is impossible because of the limited community financial capital available post disaster. External assistance is the only hope for *tambak* farmers. Until the end of 2005, *tambak* rehabilitation efforts by external parties were relatively limited and concentrated on *tambak* with minor damage, such as in Biereun and Lhok Semauwe areas. Even these rehabilitated *tambak* are not fully operational yet. Rehabilitation efforts, if any, for *tambak* with major damage such as in Banda Aceh, Aceh Besar and Meulaboh areas are very limited and only at a small scale.

Rehabilitation efforts carried out by several donors have not been well coordinated, and often assistance and target areas overlap. In practice, natural resources in many projects are being wasted.

The Aceh Marine and Fishery Department (DKP) has implemented, and will implement, various rehabilitation and reconstruction programs in the marine and fishery sectors. In the rehabilitation and reconstruction program planning document (DKP, 2005) for 2005–2009, valued at (± Rp. 952 billion), among the aims is to develop aquaculture fisheries by:

(1) compiling *tambak* zoning design details;

(2) rehabilitating *tambak* facilities and infrastructure;

(3) procuring *tambak* facilities;

(4) providing work capital for *tambak*;

(5) educating people in *tambak* aquaculture;

(6) rehabilitating and procuring shrimp germination facilities;

(7) procuring shrimp fry collection facilities;

(8) developing BBU Uleleu; and

(9) developing Loka BAP Ujung Batee.

NGOs assisting in *tambak* aquaculture fishery rehabilitation and reconstruction (also in mangrove reforestation) in the study area include: Yayasan Serambi Kasih (SERASIH); Alice; Mercy Corp; Oxfam; Terre des Hommes; World Wildlife Fund (WWF); World Aquaculture Society; Islamic Relief; France Red Cross; and Yayasan Bina Aneuk Nanggroe International institutions, such as UNDP, ADB, ACIAR, NACA and FAO are also involved in *tambak* and mangrove area rehabilitation efforts.

4.5 *Tambak* Rehabilitation Cost

This section will present a rehabilitation cost needs calculation per hectare of *tambak* based on the level of damage in the study area, and using prices from December 2005. Note that the following review excludes a calculation for intensive *tambak* aquaculture rehabilitation, as this type of *tambak* aquaculture is insignificant and managed by external investors.

Rehabilitation of *tambak* aquaculture production is not limited to rehabilitation of the physical damage, but also includes providing working capital. Cost estimate calculations for *Tambak* rehabilitation, as presented in Table 13, illustrate the *tambak* physical rehabilitation cost varies from Rp. 5.9-32.8 million, depending on the *tambak* damage level. *Tambak* with severe damage require heavy equipment (back hoe), which is the case in almost all *tambak* in Banda Aceh Municipality and Aceh Besar Regency. While *tambak* with medium and minor damage can be rehabilitated with machinery or labor, some *tambak* are forced to use heavy equipment due to abundant tsunami garbage such as concrete, aluminum, etc. lying on the *tambak* bottom. An estimate for working capital required per hectare of tambak based on technology type varies from Rp. 12.62-26.77 million per hectare for each planting season. The total funding required for *tambak* rehabilitation varies from Rp 18.5-59.5 million per hectare depending on type of damage and rehabilitation method.

Table 13. Estimates of *tambak* rehabilitation costs based on study site damage level and work capital requirements

Cost components	Cost (Rp.000/ha)				
	Severely damaged	Medium damage		Minor damage	
		Capital Intensive	Labor intensive	Capital Intensive	Labor Intensive
Physical rehabilitation					
- Machinery and materials	27,743	17,360	5,156	9,694	2,681
- Labor	5,021	3,557	7,210	2,679	3,205
Cost of physical rehabilitation	**32,764**	**20,917**	**12,366**	**12,373**	**5,886**
Working capital needed					
- Traditional	12,624	12,624	12,624	12,624	12,624
- Traditional Plus	17,951	17,951	17,951	17,951	17,951
- Semi intensive	26,770	26,770	26,770	26,770	26,770
Rehabilitation Cost					
- **Traditional**	**45,388**	**33,541**	**24,990**	**24,997**	**18,510**
- **Traditional Plus**	**50,715**	**38,868**	**30,317**	**30,323**	**23,837**
- **Semi intensive**	**59,534**	**47,687**	**39,136**	**39,143**	**32,656**

Source: primary data (processed), for 2005

4.6 Technology Alternatives

This next topic reviews various *tambak* aquaculture technology alternatives post rehabilitation. This review is carried out bearing in mind that *tambak* aquaculture in Aceh concentrates on shrimp aquaculture which is vulnerable to diseases that affect its survival rate, can change input prices such as feed and fry, and change shrimp prices. Hopefully this review will be taken into consideration in determining objectives for *tambak* aquaculture post rehabilitation. Note that this review is from the *tambak* operators' perspective only.

The review of technology selection is carried out using financial feasibility analysis and sensitivity analysis on various possible changes that could occur. Two of the financial feasibility analysis instruments used are: NPV (net present value) and IRR (internal rate of returns).

NPV is the difference between benefit/income present value and the cost disbursement present value during a certain time period at a set interest rate (see topic 3.1 above). The criteria for NPV calculations are: (1) if NPV is positive then investment is considered feasible, and can proceed; (2) if NPV is zero then the investment is capable of generating a benefit precisely equivalent to its discount rate or equal to the social opportunity cost of capital; and (3) if the NPV is negative then the investment should be reconsidered because there are other more profitable alternatives.

IRR is the interest rate of a business unit within a certain time period that makes the NVP of the business unit equivalent to nil. Mathematically the IRR is formulated as:

$$IRR = i' + \frac{NPV'}{NPV' - NPV''}\left(i'' - i'\right)$$

where i' is the interest rate that produces a positive NPV, i" is the interest rate that produces a negative NPV, NPV' is the NPV at i' interest rate and NPV" is the NPV at i" interest rate. The criteria for IRR calculations are: (1) if IRR is equivalent or higher that the prevailing interest rate, then the business execution is feasible; and (2) if IRR is lower than the interest rate or SOCC, the investment should be reconsidered.

Sensitivity analysis is carried out to observe what will happen to an investment if changes should occur in terms of cost or income. Basically this analysis is a simulation of changes in NPV and IRR in terms of input, price and output should it occur. There are three change scenarios simulated in this review.

1. Scenario-1 changes in fry price, increasing from Rp 20-/fry to Rp 100/fry. This change is very likely post *tambak* rehabilitation, where fry is in demand while the availability of the market is limited, because most of the germination areas in Aceh are damaged.

2. Scenario-2 changes in shrimp survival rate, in this event the survival rate drops to only 20%. This change is very likely with soil conditions post tsunami. The drop in survival rate is a main factor in shrimp aquaculture.

3. Scenario-3 changes in shrimp price (20%). This change is also very likely due to a decline in buying power, over stocking of shrimp, or a decline in shrimp quality.

Table 14 presents the NPV and IRR calculation results for the three scenarios above, supplemented by a no change scenario. The table illustrates that change in fry prices make traditional *tambak* aquaculture in areas of major and medium damage and requiring intensive capital rehabilitation non feasible. The others can proceed, although the NPV and IRR values become lower.

NPV and IRR calculation results for changes in survival rate (scenario 2) show that only traditional plus *tambak* with minor damage and intensive labor rehabilitation or semi intensive *tambak* aquaculture are still operationally feasible. As explained previously, the decline in survival rate means a drop in production, therefore lowering the revenue. In scenario 3, where the price of shrimp and milkfish dropped by 20%, the results show that only traditional plus *tambak* aquaculture and semi intensive *tambak* aquaculture with minor damage and intensive labor rehabilitation are feasible.

Table 14 NPV and IRR sensitivity on changes in input price and result

	Technology	Financial parameters	Level of damage due to tsunami				
			Severely damaged	Medium damage		Minor damage	
				Capital Intensive	Labor Intensive	Capital Intensive	Labor Intensive
Status Quo Scenario	Traditional	NPV	3,011	13,009	20,445	20,319	19,133
		IRR	17.7%	32.0%	58.7%	58.5%	103.7%
	Traditional Plus	NPV	32,428	42,426	49,862	49,794	55,497
		IRR	41.0%	65.9%	114.4%	113.6%	244.6%
	Semi-intensive	NPV	62,740	72,737	80,173	68,757	85,808
		IRR	58.0%	86.0%	132.2%	116.5%	219.9%
Scenario 1 (prices of shrimp fry increased)	Traditional	NPV	(13,919)	(3,921)	3,515	3,389	838
		IRR	0.7%	9.1%	23.4%	23.1%	19.8%
	Traditional Plus	NPV	9,901	19,898	27,334	27,266	32,969
		IRR	23.5%	40.3%	72.1%	71.6%	158.7%
	Semi-intensive	NPV	2,120	12,117	19,553	8,137	25,188
		IRR	16.7%	28.7%	47.2%	29.4%	82.0%
Scenario 2 (survival rate 20%)	Traditional	NPV	(26,771)	(16,774)	(9,338)	(9,463)	(10,649)
		IRR	-22.5%	-19.5%	-15.6%	-16.2%	-64.7%
	Traditional Plus	NPV	(17,906)	(7,909)	(473)	(541)	5,162
		IRR	-4.6%	2.4%	13.8%	13.6%	42.4%
	Semi-intensive	NPV	26,770	26,770	26,770	26,770	26,770
		IRR	29.6%	45.9%	72.2%	55.9%	122.3%
Scenario 3 (prices of output decrease by 20%)	Traditional	NPV	(28,227)	(18,230)	(10,794)	(10,919)	(12,105)
		IRR	-27.7%	-25.6%	-23.3%	-23.9%	-81.9%
	Traditional Plus	NPV	(19,363)	(9,365)	(1,929)	(1,997)	3,706
		IRR	-6.7%	-0.3%	10.0%	9.8%	35.2%

Technology	Financial parameters	Level of damage due to tsunami				
		Severely damaged	Medium damage		Minor damage	
			Capital Intensive	Labor Intensive	Capital Intensive	Labor Intensive
Semi-intensive	NPV	(18,795)	(8,798)	(1,362)	(12,778)	4,273
	IRR	-4.1%	2.7%	12.3%	-8.7%	28.6%

The analysis above shows that the profit and feasibility of *tambak* agriculture is sensitive to changes in *tambak* sale prices and survival rates. To ensure sustainability of *tambak* agriculture, these two variables must become the focal point for all parties involved in *tambak* aquaculture reconstruction, the *tambak* farmers themselves and the government as policy maker. The events of the mid 1990s when all farmers and *tambak* investors in Aceh suffered losses from the massive death of shrimp due to virus attack (high mortality rate) should be seriously considered.

5. Intensive Tambak Aquaculture and Mangrove Forest Existence

This chapter focuses on intensive *tambak* aquaculture and development in Aceh in relation to the existence of mangrove forest. A review of information collected through rapid assessment of the Aceh East Coast and several literature reviews supplement this chapter. The objective here is to provide an understanding of the impact of intensive *tambak* aquaculture on mangrove forests in Aceh, and further analyse the impact on marine and coastal environmental life.

5.1 Intensive *Tambak* aquaculture in Aceh

As explained in Chapter II, intensive *tambak* aquaculture has significant technical and management requirements, starting with *tambak* layout and construction through to a complex management system. Aside from high input, investment costs and capital, intensive *tambak* cannot be managed just with regular *tambak* labor. Skilled labors, including professionals, are needed. The high cost and relatively complex level of management makes this impossible for *tambak* farmers in villages. Focus group discussions with *Tambak* farmers in the study area failed to provide any information on intensive *tambak* operations during the planting season post tsunami. However, field observations at several points, uncovered the remains of aerators in villages assumed to be capable of intensive *tambak* management. According to farmers, in the 1980s through to the early 1990s, several intensive *tambak* operations in their area were managed by investors/entrepreneurs, both local and from outside Aceh, such as from Medan, including some government officials. The rapid growth of intensive *tambak* aquaculture in Aceh during the 1980s followed the rapid shrimp aquaculture development in Asia (Primavera, 1997) and Blue Revolution success (Quarto, 1996), in this case associated with a loss in mangrove forest. Farmers note that the existence of intensive *tambak* in Aceh does not contribute any benefit to the local community. Most of the investors brought well-trained labor from outside the village which has resulted in social problems in many local communities.

T*ambak* managed intensively can accelerate the level of shrimp production and increase land productivity, generating high benefit (profit) and eventually impacting on State revenue. Research shows that intensive *tambak* must be managed prudently, otherwise in the long-term it will damage/pollute the environment, which in turn will diminish land productivity. *Tambak* intensive management practices in Aceh, mostly for prawns, are usually done by converting mangrove forest (no data is available on the area of mangrove forest conversion). Such 'hit and run' practices are linked to attractive high prawn aquaculture profitability and a simple permit process for opening shrimp *tambak* area in the region. Focus group discussions found that when land is no longer productive or the contract/lease has expired or security issues occur (GAM-RI conflicts), the investor or operator shuts down the business and leaves the land unattended. At the same time, in another location, a new area is opened for intensive shrimp aquaculture.

Significant mangrove forest loss has occurred in several locations and affected local communities. They lose their income source from the mangroves, such as fish germs (pomfret and milkfish), crustaceans (such as shrimp, crab, and clam), mollusks (i.e. squid) and other marine biota that lay eggs and mature in the mangrove ecosystem. Local communities also receive benefits from mangroves such as their ability to withstand beach aberration due to waves and typhoons. They also bind sediment (waste), and prevent salt water intrusion. These protective functions disappear when mangrove forest is converted to *tambak*.

Tambak businesses all over the world especially those with intensive technology, including Aceh, have been accused of damaging and diminishing mangrove forests, and also causing water pollution in coastal areas (Quarto et al. ##, Primavera 1997, Gunawardana and Rowan, 2005).

5.2 *Tambak*, the existence of mangrove forest and fisheries

Some writings believe there is a positive correlation between mangrove ecosystems and open sea fish production. This is based on the function of mangrove forests in providing nursery grounds, feeding grounds and spawning grounds for various marine biota such as fish, shrimp, and clams (Bengen 2002). Paw and Chua (1989) state a positive correlation between mangrove area and penaeid shrimp production in the Philippines. Martusubroto and Naamin (1997) state a positive correlation between annual shrimp production and mangrove coverage throughout Indonesia. The correlation is linear with the following equation $y = 0.06 + 0.15x$, where y is the shrimp catchment result (ton/year) and x is the mangrove forest coverage (ha). Efrizal (2005) claims that mangrove ecosystems contribute 44.18 % of demersal fish (pomfret) resource production at Bengkalis Regency, Riau.

Mangrove forest conversion into shrimp aquaculture has inhibited its productive potential in terms of a catchment fishery. Gunawardena and Rowan (2005) in their review of the mangrove forests of Rekawa Sri Lanka, estimate a loss of US$34,798 annually if a 42ha shrimp *tambak* is built on the 200ha mangrove forest, as was proposed. Meanwhile de Graaf and Xuan (1998) in their Vietnam review were concerned with shrimp aquaculture growth reaching 3,500% while sacrificing mangrove forest areas with its significant real contribution to sea fish catchment: 450 kg of fish catch per hectare.

Research carried out by Ruitenbeek (1994) on mangrove ecosystem management economic analysis at Bintuni gulf, Irian Jaya, illustrates an annual net benefit value of US$235. From this value, fishery activity is the major contributor with US$117 (49.79%), followed by forestry activity with US$67 (28.51%), and local uses with US$33 (14.04%), biodiversity with US$15 (6,38%), and erosion prevention in the amount of US$3 (1,28%).

According to Sudarmono (2005), around 30% of sea fishery production depends on mangrove forests which provide breeding grounds for various marine biotas, including several fish species. Fallen mangrove leaves can be detritus for land fertility, thus attracting marine biota for laying eggs, breeding larvae, and as hunting areas for aquatic species especially *penaeidae* shrimp and milkfish (*chanos chanos*).

Inspired by the writings above, this study attempts to determine the mangrove forest interaction at Aceh Besar and Aceh Besar coastal fisheries. To observe this interaction, time series data over 21 years (1984–2004) is used for shrimp production and several small pelagic species caught using sea trawl, payang, and *klitik* net. This calculation produces biological parameter as follows: growth coefficient (r) = 0.7158, catchment capacity coefficient (q) = 2.85E-05 and carrying capacity (K) = 7,460.57. The actual production average is 1,181.83 tons.

The Fozal model is used to observe the correlation between mangrove ecosystems and fishery resources (Efrizal 2005). Mangroves are incorporated into this model by their carrying capacity function. This model is a developed version of a logistic form yield-effort model from Scheafer, as follows:

$$h = qKE(1 - \frac{q}{r}E)$$

Then, mangroves are incorporated into the equation by their carrying capacity function

$$K = \alpha \log M$$

Thus the equation becomes:

$$h = q.\alpha \, log\ M .E (1 - \frac{q}{r} E)$$
$$h = \alpha.q. \, log\ M .E - \frac{q^2 \alpha. \, log\ M}{r} E^2$$

If both sides of the equation are divided by effort, the equation above then becomes:

$$\frac{h}{E} = q\alpha \, log\ M - \frac{q^2 \alpha \, log\ M}{r} E$$
$$\frac{h}{E} = b_1 \, log\ M - b_2 \, log\ M .E$$

note :

h	=	Actual production
E	=	Effort
q	=	C*atchability* coefficient
K	=	*Carrying Capacity*
M	=	Mangrove coverage

Analysis of results shows a positive correlation between mangrove ecosystem existence and catchment fishery production, especially for shrimp and small pelagis. This interaction is illustrated in the Fozal equation, where: $h_t = 0.6883E_t + 5.23623E_t^2$ The difference between baseline fishery production and the Fozal model is shown in Table 15. And the baseline fishery resource production trajectory and the mangrove contributed production trajectory (Fozal Model) are shown graphically in Figure 9.

Table 15 and Figure 9 illustrate that mangrove ecosystems contribute 27.21% to fishery resource production in Nanggroe Aceh Darussalam (NAD) province. In other words, more than 25% of small pelagis production in the research area can be attributed to the existing mangrove ecosystem. This confirms the significant role of mangrove ecosystems in determining the level of catchment fishery production, specifically for fish, shrimp and shellfish found in mangrove forests.

Table 15 Difference between baseline fishery resource productions with Fozal model, Aceh Besar case

Year	Effort (thousand trip)	Baseline for sustainable production (ton)	Mangrove area (ha)	Sustainable production from mangrove (ton)	Divergence	
					Production (Ton)	(%)
1984	5.475	909.89	974.30	183.01	726.87	20.11
1985	5.673	933.30	949.64	195.60	737.70	20.96
1986	5.729	939.87	909.04	198.21	741.67	21.09
1987	5.542	917.93	857.99	184.03	733.90	20.05
1988	5.627	927.96	794.10	187.47	740.48	20.20
1989	5.659	931.69	722.38	186.89	744.80	20.06
1990	5.483	910.86	632.52	172.02	738.83	18.89
1991	5.819	950.17	536.33	188.55	761.61	19.84
1992	6.560	1030.10	456.77	232.95	797.15	22.61
1993	6.218	994.40	390.44	204.17	790.23	20.53
1994	6.913	1064.89	337.20	245.62	819.27	23.07
1995	6.907	1064.36	290.20	238.90	825.45	22.45
1996	8.324	1182.97	271.00	341.68	841.28	28.88
1997	8.667	1206.53	268.80	369.59	836.94	30.63
1998	8.967	1225.56	263.60	394.05	831.51	32.15
1999	8.888	1220.70	260.50	386.36	834.33	31.65
2000	9.370	1248.72	258.10	428.37	820.35	34.30
2001	9.216	1240.19	256.80	414.12	826.07	33.39
2002	10.169	1286.53	253.70	502.47	784.06	39.06
2003	10.333	1292.94	251.50	517.85	775.09	40.05
2004	11.896	1331.34	250.00	684.56	646.79	51.42
Mean	7.497	1086.23	485.00	307.45	778.78	**27.21**

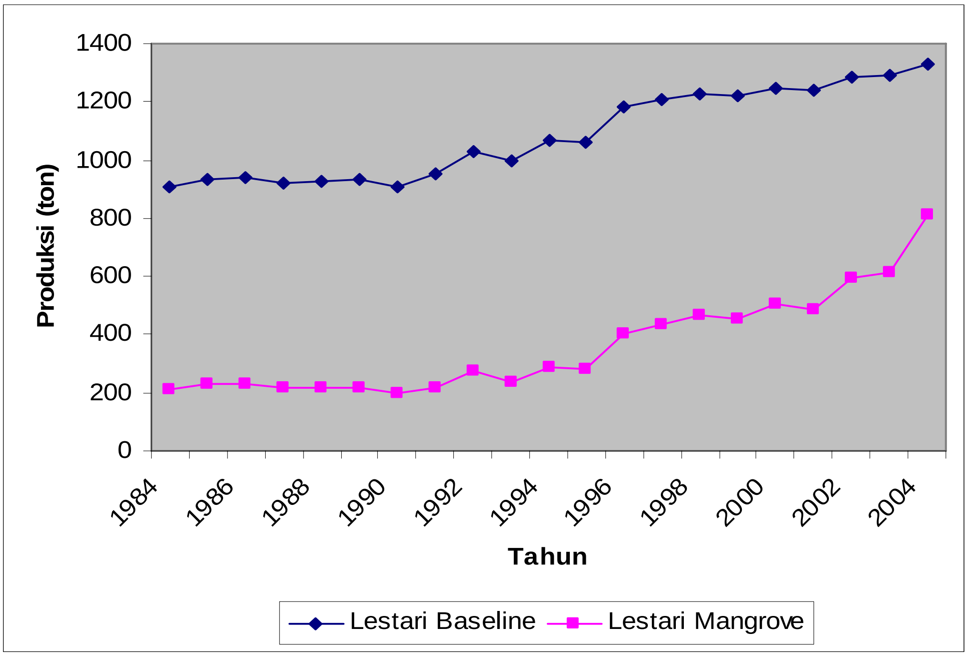

Figure 9. Sustainable yield baseline trajectory and Fozal Model from 1984–2004.

Based on the findings above, the recommended ideal (intensive) *tambak* aquaculture size in a coastal area should not exceed 30% of the entire area. Sizes vary depending on other coastal ecosystems and the ability of sea water to remove *tambak* pollution caused by the use of chemicals. The most conservative *tambak* management technology is the traditional *tambak*. Existing legal provisions must be applied consistently. Among the laws are:

1. PRESIDENTIAL DECREE (KEPPRES) No. 32 of 1990 Article 14 on greenbelt zone, stating that the beach demarcation is the land along the beach with a width proportional to the beach form and condition, at a minimum of 100m from the highest point towards land.

2. GOVERNMENT REGULATION (PP) No. 27 of 1999 on Environmental Impact Assessment (AMDAL) stating that shrimp and fish *tambak* enterprises greater than 50ha must have an AMDAL.

3. Local government policy on land use i.e. the Coastal Land Use Planning (RTRWP) which has been jointly agreed.

4. Specifically for *tambak* in Aceh, *tambak* development and management should refer to Coastal Canon (in compilation process) and existing local wisdom.

6. Concluding Remarks

The December 2004 tsunami brought Aceh and its coastal zone to the forefront of public interest and discussions on the environment and development. Conversion of mangrove forest to shrimp/fish ponds in the 1980s almost certainly increased the death toll from the tsunami. The devastation was unprecedented in recorded human history.

Brackish water aquaculture in Aceh started in traditional earthen pond systems that depended on tidal water exchange for wild seed supply and maintenance of water quality. They started in Jeunib and Samalanga (Bireun) and Seunedon and Baktiya Barat (Aceh Utara) in the 1940s by *Ulee Balang*. Brackish-water pond establishment along the north-east coast grew rapidly in the late 1970s in line with the development of semi-intensive shrimp farming. It evolved into a system of deliberate stocking wild or hatchery fry in increasing densities, supported by feed and water management inputs which increase yields.

Extensive conversion of mangrove forest for shrimp farming in Aceh began in the early 1960s, when a Medan-based investor provided a credit scheme for shrimp culture to groups of 40 farmers. Through a license (*surat izin menggarap*) issued by the village head (*keuchik*), those who did not have land could use any available land in the village, and most converted mangrove forest for aquaculture. The shrimp cultivation boom in Southeast Asia from 1970 to the 1990s (Primavera, 1997) was a driving factor in the development of brackish-water ponds in Aceh, both in the size of the area under cultivation and the adoption of more intensive technologies. At the expense of this was a loss of mangrove forests.

It is well known that the average operational life of a shrimp pond is two to three years, as chemical feeds and fertilizers coupled with pesticides (used in aquaculture) deteriorate water quality to the point that it cannot raise healthy shrimp. At this point, shrimp ponds are usually abandoned and investors move on to clear new areas of mangrove forest. It is well-understood that the presence of intensive shrimp culture is highly dynamic and depends on the world price.

Shrimp and milkfish farms in Aceh are mainly operated under a traditional aquaculture system (74.7%), with low input farming systems of polyculture and/or monoculture along the north-east coast. Of the total, 22% are semi-intensive farms, mostly found in Bierun and Pidie. Only 3.2% are intensive shrimp farms. The number of intensive and semi-intensive shrimp farms on the west coast of Aceh has started to increase over the past five years.

With regard to property rights, not all *tambak* are established on privately owned land. It is estimated that 19.8% of the *tambak* area in the 12 villages under study are established on non-private land and only 36.5% of those on privately-owned land have land certificates. Land with this kind of secured title is mostly found in the urban areas closest to Banda Aceh (Tibang and Lambaro skep, 99.5% and 44.9% respectively) and Pidie (Baroh Lancok, 43.9%). In rural areas, the amount of private land with land certificates is very low, less than 15%. It is important to develop a sustainable strategic livelihood for the future on lands where people are vulnerable to eviction.

Post Tsunami: A lament for the brackish-water pond in Aceh Province

Most of physical capital developed over decades to support *tambak* production was washed away with the tsunami. An assessment carried out by FAO (Philip and Budiman, 2005: 34-37) weeks after the natural disaster, noted that 20,429 ha or 42.9% of *tambak* in the province, with varying degrees of damage, lost its production capacity[8]. About 1,000ha of *tambak* were permanently inundated due to the shift in coastal line inward and 7,300ha were severely damaged. It is not clear if yields were lost in those areas which were only inundated during the time of tsunami. Regarding infrastructure, 810km (66.8%) of irrigation channels and 193 units (out of 223) hatcheries were severely damage.

Damage to the *tambak* from tsunami includes: (1) structural damage such as destruction of dykes, damage to irrigation channels, water gates and loss of associated infrastructure (huts, pumps, machinery); and (2) sedimentation caused by the deposition of debris, silt, sand and mud into ponds and irrigation canals. It should be noted that silting up as a result of sand and debris from the tsunami was widespread along the north-east coast, filling even those ponds without structural damage. *Tambak* that silted up requires more effort to repair, whereas damage to the embankments is relatively easy to repair. T*ambak* situated between settlements also filled with debris from buildings, and restoration of this *tambak* is the most difficult.

Thousand of shrimp/fish farmers lost their income as well as their working capital. Sudden loss of working capital brought about serious impacts to the availability of financial capital in communities. A quick assessment carried out in December 2005 in 12 villages of the six regencies with the largest brackish-water pond area in the province (Banda Aceh, Aceh Besar, Pidie, Bireun, Lhok Seumawe, and Aceh Utara) found out that 92% of *tambak* farmers rely on traditional money lenders (*toke*) who provide working capital and serve as marketing agents. As a result of the tsunami disaster, all *toke* lost their capital and there is virtually no way for them to recover quickly from this.

Tambak Rehabilitation – a year after the tsunami

Efforts to restore the physical capital vary depended on the level of damage. A year after the tsunami hit the province, some patches of damaged *tambak* have been restored by international organizations working together with national partners, although this number is still very low. Rehabilitation started from the less damaged *tambak* such as in Biereun and Lhok Semauwe, while rehabilitation of the more damaged *tambak* started in September 2005 and has been implemented over a relatively small area. No hard data is available regarding the progress of these efforts. The estimate is that less then 15% of the *tambak* have been restored.

Observations in December 2005 found an interesting phenomenon occurring with rehabilitation efforts. Firstly, very few *tambak* that had already been restored were being optimally used, mostly because of a lack of available working capital. Some *tambak* had returned to cultivating shrimp, but had failed due to water quality. Groups of young people in Kuala Meuraksa of Blang Mangat, were already running a grouper nursery, with orders from a

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[8] Brackish-water farming contributes highly significant to overall fisheries values in Aceh; 32% of total fishery value. MAFF/World Bank figures give the fishery sector of Aceh a value of Rp 1.59 trillion, or US$176.67 million(Philip and Budiman, 2005: 2)

Medan- based trader. They nurse grouper from fry to three-inch fingerlings for two months, then sell them to investors. A group of three could earn Rp 5-7.5 million or the return to labor for the grouper nursery is approximately Rp 61,250 per person-day. The economic scale of this activity was 10,000 tail of fry per group assuming a 70% survival rate. This return to labor is considerably higher then the agricultural labor wage rate.

The second issue relates to restoring *tambak* with unclear land status. An international aid agency (NGO) faced this land status problem in restoring the severely damaged *tambak* areas in Lamnga and Gampong Baru of Kecamatan Mesjid Raya. The rehabilitation plan that was developed with the community cannot be implemented in some parcels of *tambak* because of unclear land status. The land had been part of the mangrove area rehabilitation (under NAD-Nias Rehabilitation and Reconstruction Board) and the NGO therefore had to leave the area untouched. This created tension between group of farmers and NGO staff, a situation that easily happen elsewhere if the land status is unclear.

Third is the problematic nature of *tambak* rehabilitation on sandy soil close to the shoreline. The existence of *tambak* close to the shoreline is actually against the old *adat* rule, which says that 200 meters (150 *depa*) from the shoreline must be free from any cultivation that disturbs fishing activities. This rule is no longer practiced as *tambak* provides greater income to coastal communities, but unfortunately they are also vulnerable to tide waves. The case of Meunasah Lancok, Kecamatan Samalanga is one such example. Only a few weeks after it had been rehabilitated, the embankments of blocks of sandy *tambak* collapsed and the ponds were flattened by the sand in a single, relatively high, tide. The first impression one might have is of a waste of resources, because reconstructing a sandy *tambak* requires more effort than for a more solid grounded *tambak*.

Fourth is the issue of gender in restoring *tambak*. Many Acehnese perceive that *tambak* farming is a male activity. Efforts to provide more opportunities and roles for women in *tambak* rehabilitation in the village of Pidie, initiated by an Italian NGO, failed and the NGO received protest from the community.

A year after the tsunami, *tambak* rehabilitation appears to be very slow. *Tambak* rehabilitation should consider the balance between the economic potential of coastal resources and environmental problems that could occur in the future as a result of exploiting coastal resources. The conflict between public and private interest should be internalized into the rehabilitation process. Multilevel social networks are crucial for developing social capital and for supporting the legal, political, and financial frameworks that enhance sources of social and ecological resilience (Dietz etal, 2003).

Financial assessment of brackish-water pond rehabilitation

Based on the data collected from several *tambak* rehabilitation activities in villages, the cost of *tambak* rehabilitation per hectare is estimated at between Rp. 5.89 million and Rp 32.41 million depending upon the level of damage and the method used; capital intensive (using back hoe) or labor intensive (done manually). Labor intensive rehabilitation will never work to reconstruct severely damaged *tambak*, while other level damage can be done manually (labor intensive) or using backhoe (capital intensive). *Tambak* rehabilitation using a back hoe is faster than if it is done manually. Both methods employ unskilled labor that is available locally, providing employment opportunities for the local community.

Ex ante financial assessment of brackish water pond production after reconstruction, was carried out based on December 2005 prices. Traditional systems practiced by the largest *tambak* operator in the province, are still profitable under 15% discount rate, and it is assumed that the survival rate for shrimp fry and milk fish is 48% and 70% respectively. Initial capital ranges from about Rp 18.5 million to Rp 45 million per hectare (cost of establishment and working capital). In normal conditions, this amount is affordable. However, in situation such as exists in Aceh at present, it is not affordable for smallholder shrimp/fish farmers. Return to labor (which converts surplus to a wage after accounting for purchased inputs and discounting for the cost of capital with no surplus attributed to land) is marginally higher than the average agricultural wage rate. This makes *tambak* aquaculture attractive for farmers.

At the other extreme, an intensive *tambak* system requires more initial capital ranging from Rp. 57.86-84.1 million. This provides the highest profitability, although it assumes a production scenario whereby there will only be seven effective years out of 11. All these calculations do not internalize the social cost of mangroves lost, the environmental and social damage associated with problems of pollution, the public health risks and salinization caused by intensive shrimp farming. These factors are in stark contrast to the values of communal ownership, coastal protection and domestic food supply intrinsic to intact mangroves (Primavera 1993). These values need to be monetized to provide more comprehensive information to national governments and international funding organizations which have been working on *tambak* rehabilitation in Aceh. Institutions that protect local communities and the environment from short term profit-makers must be developed and supported and their rules must be enforced. (Primavera 2000)

From an employment generation point of view, brackish-water aquaculture is a good option because it has a reasonably better return to labor than that of other agricultural activities in rural areas. Brackish-water aquaculture requires 395–813 person-days per hectare per year to operate, depending on the technology. Intensive systems require more labor than traditional systems. It appears that intensive systems would provide more employment for local communities, however this does not always happen in reality. The experience in Aceh is that *tambak* operators are often not from the local community and so very little local labor is employed. This can create tension between local communities and migrant laborers working the intensive shrimp farms.

Conclusion

The capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human livelihoods can no longer be taken for granted. Socio-ecological resilience must be understood at a broader scale and actively managed and nurtured. Incentives for generating ecological knowledge and translating this into information that can be used in governance are essential. (Adger et al, 2005).

The ‘human causation’ element of the tsunami impact has received a lot of attention for the city of Banda Aceh which lost its protective mangroves in the 1980s due to conversion to urban use. Attention to ‘human causation’ is in line with a general tendency that judges the seriousness of an environmental loss by what caused it (Brown et al., 2005). The effects on the rest of the coast are more difficult to quantify, but are still important in the debate. The social cost of past conversion of mangroves to *tambak*s was previously estimated primarily based on the value of open-sea fisheries (Turner, 1977).

Although estimates indicate that the 'social value' of intact mangroves is much higher than the 'private value' of converted mangroves, there is no mechanism to provide benefits which might prompt those with the right to convert mangroves to reconsider their decisions. Part of the tsunami damage can thus be seen as the result of institutional failure to internalize externalities.

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Appendix

Pedoman Wawancara Terstruktur
Kajian Sosial – Ekonomi Budidaya Tambak di Aceh

Tujuan Studi

Melakukan kajian sosial-ekonomi secara luas menyangkut budidaya tambak di NAD Dalam rangka melengkapi pengetahuan guna mendapatkan gambaran yang lebih baik untuk usaha pemulihan kehidupan masyarakat yang sebelum tsunami menggantungkan hidupnya dari budidaya tambak, diperlukan kajian tentang masalah-masalah.

No	Issue	Aspek	Sumber data
1	Ownership patterns (Pola Pemilikan tambak)	▪ Berapa % tambak yang dimiliki oleh petani tambak dan berapa % yang dimiliki oleh investor dari luar (yang tidak tinggal di lokasi tambak) - Tambak Tradisional - Tambak Intensif - Tambak Semi intensif ▪ Bagaimana kesejahteraan pemilik tanah skala kecil dibandingkan dengan nelayan dan petani padi/lahan	▪ Wawancara - PPL/BPP - Ketua perhimpunan tambak - Keuchik - Dinas ▪ Pendekatan teknologi yang digunakan Data sekunder - Data terdahulu (hasil penelitian) disesuaikan dengan harga sekarang - Return to land (perkapita) - Kasus-kasus pertani tambak, petani lahan - Kasus di dalam box - Produktivitas tenaga kerja -
2	Employment/ Kesempatan Kerja	Benefit tambak bagi masyarakat sekitar ▪ Siapa saja yang bekerja untuk budidaya tambak - Darimana mereka (luar atau dalam) - Status kesejahteraannya pekerja ▪ Benefit apa yang diberikan - Upah, dalam bentuk apa? - Pembagian hasil - Lain-lain ▪ Hubungan antara pemilik dan pekerja	- Struktur demografi berdasarkan pekerja, usia produksi.

No	Issue	Aspek	Sumber data
		Struktur/pola pengelolaan tambak (pemilik, pemodal, pengelola): **(Pola perjanjian)** ▪ Pemilik = pemodal = pengelola ▪ (Pemilik = pengelola) = bukan pemodal (kredit) ▪ Pemilik bukan (pengelola = pemodal) (sewa, bagi hasil) ▪ (Pemilik = pemodal) bukan pengelola ▪ Rent seeker (sebagai makelar) ▪ Menjadi buruh di lahan sendiri	
3	Production systems	▪ Sistem produksi tambak apa saja yang ada pada saat tsunami (udang, campuran udang dan bandeng). - Tradisional - Semi intensif - Intensif	- Data sekunder (data statistik) - Analsisis ekonomi dan analisis finansial - Laporan penelitian
4	Legal	Aspek legal dari pemilikan tambak 1. - Proses kepemilikan tambak tradisional (historis) - Proses kepemilikan tambak yang dioperasikan oleh investor 2. Status tanah/lahan tambak - Tanah milik (tanah yang sudah dibebani hak atas tanah, seperti hak milik, HGU, dan Hak pakai........bersertifikat - Tanah ulayat (tanah milik masyarakat adat) - Tanah negara (tanha yang belum dibebani hak 3. Alih fungsi lahan (dikaji) 4. Tsunami - Tanah musnah (tanah yang secara phisik dan fungsinya tidak dapat dikembalikan seperti semula) ....relokasi (cadangan tanah yang tersedia) - Kajian/identifikasi perangkat hukum yang mendukung proses rekonstruksi tambak 5. Mekanisme penyelesaian sengketa - Litigasi (pengadilan) - Nonlitigasi (ADR: mediasi, arbitrase) **6. Daftar pertanyaan untuk BPN (assesment dimulai dari BPN)**	▪ Kanwil BPN ▪ Kantor Pertanahan ▪ Dinas Perikanan dan Kelautan ▪ Biro Hukum dan Kabag. Hukum ▪ Camat ▪ Mukim ▪ Kepala Desa/ Keuchik ▪ Petani tambak ▪ Tokoh masyarakat

No	Issue	Aspek	Sumber data
		- Berapa luas lahan tambak - Berapa yang memiliki/dibebani hak - Berapa luas yang berada di atas tanah ulayat - Berapa luas yang berada di atas tanah negara Semua pertanyaan di atas dikomparasikan dengan setelah tsunami	
5	tambak production financed	**Pembiayaan budidaya tambak** - Sumber dana apa saja (sendiri atau kredit) Kredit : investasi atau modal kerja Apa lembaga kreditnya: bank, tengkulak, koperasi, dll - Bagaimana produksi dipasarkan: rantaio pemasaran - Apa yang terjadi setelah tsunami terhadap sistem pembiayaan dan pemasaran di atas - Apakah ada sektor swasta (NGO, investor sewasta) terlibat dalam restorasi tambak, dimana: jika ada, apa yang dilakukan, bagaimana caranya (syaratnya) **Informasi tambahan:** Sebelum tambak (yang rusak) berproduksi, apa sumber pendapatan petani tambak, saat ini, dimana mereka tinggal)	

Konsep yang harus mendapat penjelasan dari berbagai informan kunci

1. **Investor luar**
   - Batas administrasi
     - Di luar kecamatan
       - dalam kabupaten yang sama
       - di luar kabupaten
       - di lau provinsi
     - Di dalam kecamatan

     Harus didukung data data produksi

     - Sebelum tsunami dan MoU keamanan tambak di beberapa daerajh tertentu dipercayakan kepada aparat GAM
     - Keamanan dijadikan salah satu varibel yang akan diteliti). Biaya keamanan masuk dalam biaya produksi
   - Etnis (untuk memperkaya informasi)

2. **Konsep Teknologi budidaya tambak**

- Tradisional
- Intensif
- Semi intensif

Informasi di dapatkan dari dinas perikanan dan harus dibandingkan antara konsep DKP, kenyataan di lapangan dan titik pandang teoritis,

3. **Ukuran Kesejahteraan**

- Nelayan (jenis mesin, jenis jaring, ukuran boat)
    - pemilik kapal
    - awak kapal
- Pendapatan (Perbandingan antara biaya operasional dan nilai hasil)

4. **Signifikansi**

- % income
- Multiplier effect
- Kesempatan bekerja bagi si miskin

5. **Struktur/pola pengelolaan tambak (pemilik, pemodal, pengelola):**

(Pola perjanjian)

- Pemilik = pemodal = pengelola
- (Pemilik = pengelola) = bukan pemodal (kredit)
- Pemilik bukan (pengelola = pemodal) (sewa, bagi hasil)
- (Pemilik = pemodal) bukan pengelola
- Rent seeker (sebagai makelar)
- Menjadi buruh di lahan sendiri

7. **Ada daerah-daerah produksi**
    - **Unit/Satuan Analisis:** Komunitas budidaya tambak

8. **Kriteria penarikan desa Sample**
    - Daerah yang terkena tsunami: kabupaten/kota yang kerusakan tambaknya sangat parah
        - i. Kota Banda Aceh
            1. Kecamatan Kuta Alam
            2. Kecamatan Syiah Kuala

ii. Kabupaten Aceh Besar
    1. Kecamatan Peukan Bada
    2. Kecamatan Mesjid Raya (Desa Lamnga)
iii. Kabupaten Pidie
    1. Kembang Tanjong
    2. Pante Raja atau Bandar Baru
iv. Kabupaten Bireun
    1. Samalanga
    2. Jeunib

- Teknologi budidaya yang digunakan

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Who we are

The World Agroforestry Centre is the international leader in the science and practice of integrating 'working trees' on small farms and in rural landscapes. We have invigorated the ancient practice of growing trees on farms, using innovative science for development to transform lives and landscapes.

Our vision

Our Vision is an 'Agroforestry Transformation' in the developing world resulting in a massive increase in the use of working trees on working landscapes by smallholder rural households that helps ensure security in food, nutrition, income, health, shelter and energy and a regenerated environment.

Our mission

Our mission is to advance the science and practice of agroforestry to help realize an 'Agroforestry Transformation' throughout the developing world.

FUTURE HARVEST CGIAR

A Future Harvest Centre supported by the CGIAR

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