Sea Farming and Its Contribution to Poverty Alleviation: An Empirical Study from Indonesia

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Abstract

This study aims to examine the factors influencing participation of sea farming project and impacts on household income and poverty in Panggang Island, Kepulauan Seribu, Indonesia. The benefits and constraints of the project are also discussed. The probit regression shows that education, occupation, household size, organization member, mariculture experience, and mobile phone ownership are significant factor influencing household decision to participate in the project. The OLS regression shows that organization member, mariculture experience, and mobile phone ownership has positive and significant influence on household income. The findings show that sea farming has positive impact on household income but it needs a lot of improvement to be able to affect poverty on a larger scale.

Keywords: sea farming, aquaculture, mariculture, poverty, Panggang Island

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List of Abbreviations

BPS	*Badan Pusat Statistik* (Statistical Bureau)
CCMRS	Center of Coastal and Marine Resources Study
CDF	Cumulative Distribution Function
CPR	Common Pool Resource
CSR	Corporate Social Responsibility
DC	Developing Countries
FAO	Food and Agriculture Organization
IAA	Integrated Aquaculture-Agriculture
KAKS	*Kabupaten Administratif Kepulauan Seribu* (Kepulauan Seribu Administrative Regency)
LDC	Least Developed Countries
NGO	Non-governmental Organization
OECD	Organisation for Economic Co-operation and Development
RT	*Rukun Tetangga* (Neighborhood)
RW	*Rukun Warga* (Pillar of Residents)
SF	Sea Farming
SSF	Small-scale Fisheries

1. Introduction

1.1 Background

The world fish food supply has been outpacing global population growth for the last five decades. During 1961–2009 the average growth rate of fish production remained at 3.2% per year and is outpacing the average growth rate of world's population, which increased by 1.7% per year in the same period (FAO, 2012).

The world fish supply is the sum of capture fisheries and aquaculture. Capture fisheries refers to all the fish catch in the natural habitat such as seas, lakes and in freshwater. Aquaculture is defined as the production of aquatic plants and animals under controlled or semi-controlled conditions for direct or indirect human consumption (Stickney, 2000). Aquaculture embraces culture in all salinities, from freshwater through brackhiswater and seawater to hypersaline water.

Table 1. World Fisheries Production and Utilization

	2006	**2007**	**2008**	**2009**	**2010**	**2011**
			(*Million tonnes*)			
PRODUCTION						
Capture						
Inland	9.8	10.0	10.2	10.4	11.2	11.5
Marine	80.2	80.4	79.5	79.2	77.4	78.9
Total Capture	**90.0**	**90.3**	**89.7**	**89.6**	**88.6**	**90.4**
Aquaculture						
Inland	31.3	33.4	36.0	38.1	41.7	44.3
Marine	16.0	16.6	16.9	17.6	18.1	19.3
Total Aquaculture	**47.3**	**49.9**	**52.9**	**55.7**	**59.9**	**63.6**
TOTAL WORLD FISHERIES	**137.3**	**140.2**	**142.6**	**145.3**	**148.5**	**154.0**
UTILIZATION						
Human consumption	114.3	117.3	119.7	123.6	128.3	130.8
Non-food uses	23.0	23.0	22.9	21.8	20.2	23.2
Populations (*billions*)	6.6	6.7	6.7	6.8	6.9	7.0
Per capita food fish supply (*kg*)	17.4	17.6	17.8	18.1	18.6	18.8

Source: FAO (2012)
Notes: Data exclude aquatic plants. Totals may not match due to rounding. Data for 2011 are provisional estimates.

Table 1 shows data of world fisheries production and utilization. The data exhibits a staggering production of 148.5 million tonnes of fish in 2010. It also shows the growing demand of fish and fishery products. With the growing demand, there are some serious constraints on fulfilling this appetite by only

capture, which is considered as unsustainable course of action. Irresponsible fishing may cause overfishing and resource depletion. Consequently, the amount of capture's trend is decreasing since 2008 (Table 1). Aquaculture seems to be one of the solutions to this problem. Its share in world fisheries production is increasing every year and it has become the fastest growing animal food producing sector compared to beef, pork or poultry globally (FAO, 2012; OECD, 2010).

Aquaculture is spread widely and practiced successfully in Asia. The region accounts for 89% of world aquaculture production (FAO, 2012). Rapid growth of aquaculture in Asia was driven by variety of factors, such as pre-existing aquaculture practices, population and economic growth, underdeveloped coastline with abundant supplies of water, less strict regulatory framework, and greater export opportunities (Bostock et al., 2010; Stickney, 2000).

Being the largest archipelagic state in the world[1], Indonesia has become the fourth largest producer of aquaculture products, which contribute 2.3 million tonnes (3.85%) to world aquaculture production in 2010 (FAO, 2012). However, its potential is estimated to be 57.7 million tonnes per year (Trobos, 2012) and there is around 16.6 million hectare area, which can be developed for aquaculture activities (KKP, 2011). The Indonesian government has been trying to boost its aquaculture production through *minapolitan*, industrialization, and other programs. This is because of the increase in aquaculture production could also contribute to the improvement of crucial development indicators such as poverty alleviation, food security and malnutrition, women empowerment, and environmental sustainability.

The location of the study is at Kepulauan Seribu area, which lies on the Java Sea at the north of Jakarta (see Figure 2, section 3.1). Formerly, Kepulauan Seribu is part of the North Jakarta city and its status was raised to independent administrative regency in 1999 in order to increase the development of the region

[1] Indonesia has 17,504 islands and 104,000 km length of coastline (KKP, 2011).

(BPS KAKS, 2011). There are 110 islands in the region but only eleven are inhabited with a population of 21,082 in 2010. Based on BPS KAKS (2011), the main sources of income in Kepulauan Seribu are fisheries, services, trade and tourism (38.5%, 22.73%, and 22.05% of total population respectively).

Although Kepulauan Seribu is near the capital city, but the local community did not enjoy the fruit of economic development. In fact, they are suffering from pollution and environmental degradation because of mining, marine transport, irresponsible and destructive fishing activities. In fisheries sector, most of local community works on small-scale fisheries (SSF) and they have to face competition with the outsiders who use more sophisticated fishing gears and vessels. As a result, their fishing ground is overfished and this condition has prevailed since the beginning of 1990 (Solihin et al., 2011). To overcome two crucial problems in Kepulauan Seribu, poverty and declining capture fisheries' productivity, CCMRS[2] (Center for Coastal and Marine Research Studies) and the local government was working to create "sea farming project" in Panggang Island village. This village is part of North Kepulauan Seribu district, Kepulauan Seribu administrative regency.

Sea farming is a project to create sustainable shallow marine resource management system. It uses mariculture[3] as a base-activity as well as supporting other activities such as capture and marine ecotourism (CCMRS, 2006). The project implementation was in 2005 to 2010. Even though the project was completed in 2010, to date, CCRMS still provides counseling to sea farming members and raises fund from other organizations to maintain the sustainability of sea farming project.

The goals of sea farming project are to improve local community's welfare and to conserve marine ecosystem. The project activities are (1) setting up the regulation, institution and infrastructure; (2) provide knowledge and skill-based training; (3) provide fingerling; (4) connect sea farming member to the market; and (5) provide counseling. There were 75 households that participated in the

[2] CCMRS is a research institution for coastal, marine and fisheries studies under Bogor Agricultural University.
[3] Mariculture is the production of organisms in seawater; thus, it is more exclusive than aquaculture, which relates to culture activities in both freshwater and marine ecosystem (Stickney, 2000).

project within the period of 2005 to 2008. At present, only 51 households remain active in the mariculture activity due to the lack of fingerling stock (Rudiyanto, 2011).

The mariculture activities in the project specifically focus on rearing of brown marbled grouper (*Epinephelus fuscoguttatus*) and humpback grouper (*Chromileptes altivelis*), which are considered to have relatively high economic value. They use floating cage culture technique to rear the groupers in the shallow water area (5-17 m depth), which has sandy and rocky substrate with 0.15-0.35 m/sec stream velocity (Solihin et al., 2011). CCMRS reported that member of sea farming produced 30 to 1,000 kg/year during 2006-2009[4]. They sold their catch to the middlemen in Jakarta who in turn sell it to the local market and to exporters destined for consumption in Singapore, Malaysia, and Hongkong.

Previous studies on sea farming were focusing on the institutional analysis, transaction costs, strategic development, cost and benefit analysis, economies of scale, management performance, empowerment, and aquaculture technical issues (Haswanto, 2006; Hariri, 2010; Puspitasari, 2008; Rahayu, 2009; Rangkuti, 2008; Rio, 2009; Rudiyanto, 2011; Wahyuni, 2008). This study would like to evaluate whether or not the project is beneficial for the local community and can be applied in other areas. Therefore it is necessary to evaluate project's impact, which intends to determine whether the project had the expected effects on individuals, households, and institutions targeted by the intervention (Baker 2000).

1.2 Research Questions and Objectives

To learn whether the project achieved its goal in improving welfare of the local community, this study is using poverty as one of the indicators to measure welfare, since poverty and welfare are related to each other. Esping-Andersen (2000) mentions that poverty, years of schooling, and unemployment rates can be use as welfare indicators. The research objective of this ex-post study is to determine the impact of sea farming on poverty alleviation in Panggang Island.

[4] Data is taken from CCMRS's field facilitator who is responsible for sea farming in Panggang Island village (based on oral permission from Deputy of CCMRS). This data is also used in Rudiyanto's master thesis (2011).

There are three research questions that the study aims to answer, those are:

1. What are the factors that determine household participation in project activities?
2. What are the project impacts on household income and poverty?
3. What are other benefits and constraints of the project subjectively felt by community members?

To address these questions, a survey of project participants and non-participants in the community was carried out. For the first two questions, quantitative data on household income and other socioeconomic characteristics were evaluated using statistical techniques. For the third questions, survey responses to open-ended questions were analyzed, supplemented by relevant literature sources.

1.3 Organization of the Study

This thesis is organized as follows: chapter 2 provides theoretical and empirical literature review. In this chapter, some poverty definitions, its measurement, the linkages between aquaculture and poverty alleviation, and factors that determine individual participation in the project are described. Chapter 3 presents the methodology of the study, for example the sources and different types of data, survey design, data analysis, and limitations of the study. Chapter 4 present grouper culture and sea farming project in Panggang Island, descriptive statistics and estimation result, as well as describing benefits and constraints of sea farming from local community's perception and other relevant literature. Finally, chapter 5 concludes with some policy implications.

2. Literature Review

2.1 Definition, Types, Dimensions, and Measurement of Poverty

Defining poverty is complicated because it is critical to some debates about the concept from political, policy and academic point of views (Lister, 2004). Hence there are several poverty definitions, though in general it can be categorized into two schools of thoughts, which based on monetary terms and more broad-based concept (Klasen, 2000). On the World Bank Development Report 2000/2001, poverty defined as "*pronounced deprivation in well-being*" (World Bank, 2000, p.15). The first group views well-being as command over commodities and the poor as those who do not have sufficient income or consumption to fulfill their needs (Haughton and Khandker, 2009), whilst the second group views well-being from the capability of individual to function in a community rather than just the inadequacy of income (Sen, 2001).

Based on two different approaches in defining poverty, we consider two types of poverty that is absolute poverty and relative poverty (Giddens, 2009). Charles Booth and Seebohm Rowntree[5] define absolute poverty as lacking sufficient money to meet basic physical needs (Lister, 2004). Meanwhile, Townsend[6] (1979) defines relative poverty as lacking of the resources required to obtain the types of diet, participate in activities, and enjoy living standards that are customary or widely accepted in the society where they belong. In spite of two different approaches in defining poverty, Hagenaars and de Vos (1988, p.212) argue that basically "*all poverty definitions can be fit into one of the following categories:*

1. *Poverty is having less than an objectively defined, absolute minimum (absolute poverty);*
2. *Poverty is having less than others in society (relative poverty); and*
3. *Poverty is feeling you do not have enough to get along (absolute, relative or somewhere in between absolute and relative poverty).*"

[5] Charles Booth (1840-1916) and Seebohm Rowntree (1871-1954) are the pioneers of modern poverty research in the 19th century.

[6] Peter Brereton Townsend (1928-2009) is a British sociologist and dedicating himself to poverty study.

Nowadays, poverty is viewed as multidisciplinary issue since every discipline has different perspectives on it (Kakwani and Silber, 2007). It also has multiple dimensions, such as income, life expectancy (longevity) and health, malnutrition, literacy and education, unemployment, inadequate shelter, vulnerability, voicelessness and powerlessness, freedom, security, opportunities, social exclusion, capabilities, and functioning (Sen, 2001; Thorbecke, 2007; World Bank, 2000).

There are number of conceptual approaches to measure poverty and the broader the definition of poverty, the more difficult is its measurement. However, the most common approach is based on household income and consumption expenditure (World Bank, 2000). The two approaches have advantages and disadvantages (Table 2).

Table 2. Income versus Expenditure in Measuring Poverty

	Income	Expenditure
Advantages	a. Easy to measure. b. Measures degree of household "command" over resources. c. Less expensive in data collection.	a. Shows current actual standard of living. b. Less understated (easier to recall). c. More stable indicator in long term.
Disadvantages	a. Likely to be under-reported. b. Possible to be affected by short-term fluctuations. c. Some parts of income are difficult to observe (e.g. informal sector). d. Income and welfare relationship is not always clear. e. Reporting period might not capture household average income.	a. Household consumption choices may be misleading (e.g. modest lifestyle of rich household). b. Household may not be able to smooth consumption (e.g. borrowing). c. Some expenses are not incurred regularly (may cause noisy data). d. Difficult to measure some components of consumption.

Source: Haughton and Khandker (2009)

Considering the complexity of poverty and its very-broad dimensions, as well as the scope of this study, the poverty definition used in this study is the one that is based on monetary term, using income as the approach to measure poverty.

2.2 Aquaculture and Poverty Alleviation

The development of the agricultural sector is believed as one of the main impetus for reducing poverty and ensuring food security in rural areas (Halwart, 2005). Aquaculture forms an important component within agriculture particularly in coastal areas. Aquaculture development has been used by donor countries and non-governmental organizations (NGOs) to reduce poverty and hunger in

developing countries (DC) and least-developed countries (LDC), such as in Sub-Saharan Africa since 1980s (Beveridge et al., 2010).

Nevertheless, the contribution of aquaculture to poverty alleviation and other development issues remains questionable. Some empirical studies show that aquaculture has positive contribution to poverty alleviation (Edwards, 2000; Irz et al., 2007; Kaliba et al., 2007), food security and malnutrition (Ahmed and Lorica, 2002; Dey et al., 2008; Thilsted, 1997), women empowerment (Gurung et al., 2010; Amarasinghe and Nguyen, 2010), and environmental sustainability (Umesh et al., 2010; Weimin, 2010).

Meanwhile others argue that aquaculture only benefitted few people in society (Bailey, 1988; Bergquist, 2007; van Mulekom, 2006) and is perceived as unsustainable and environmentally degrading (Aldhous, 2004; Allsopp et al., 2008; Naylor et al., 1998, 2000; van Mulekom et al., 2006). However, most of these negative perceptions refer to shrimp and salmonid aquaculture, the two practices that contribute less than 10% by volume and approximately 16% by value to overall global production (De Silva and Davy, 2010). Figure 1 shows linkage of aquaculture to development aspects of individual and community.

Aquaculture contributes in poverty alleviation as it generates job opportunities, both in the sector itself as well as in supporting sectors (Aye et al., 2007; Dey et al., 2008; Halwart, 2005; Phuong and Oanh, 2010). In Vietnam, the striped catfish farming become extremely important on the aquaculture sector when it accepted as "white flesh" fish substitutes in Western countries. Its production and export reached 1,200,000 tons worth USD 1 billion in 2007, and most importantly, it became the trigger for the development of processing sector which provides 150,000 livelihoods mostly for rural women (Phuong and Oanh, 2010).

In some African countries, where aquaculture performance is not as spectacular as in Asia, aquaculture development has the potential in reducing poverty for example in Egypt, Ghana, Kenya, Malawi, Nigeria and Uganda (Hiheglo, 2008; Jamu and Ayinla, 2003; Kaliba et al., 2007; Ogundari and Ojo, 2009; Russel et al., 2008; WorldFish Center, 2011). Research of Dey et al. (2007) as cited in Russel

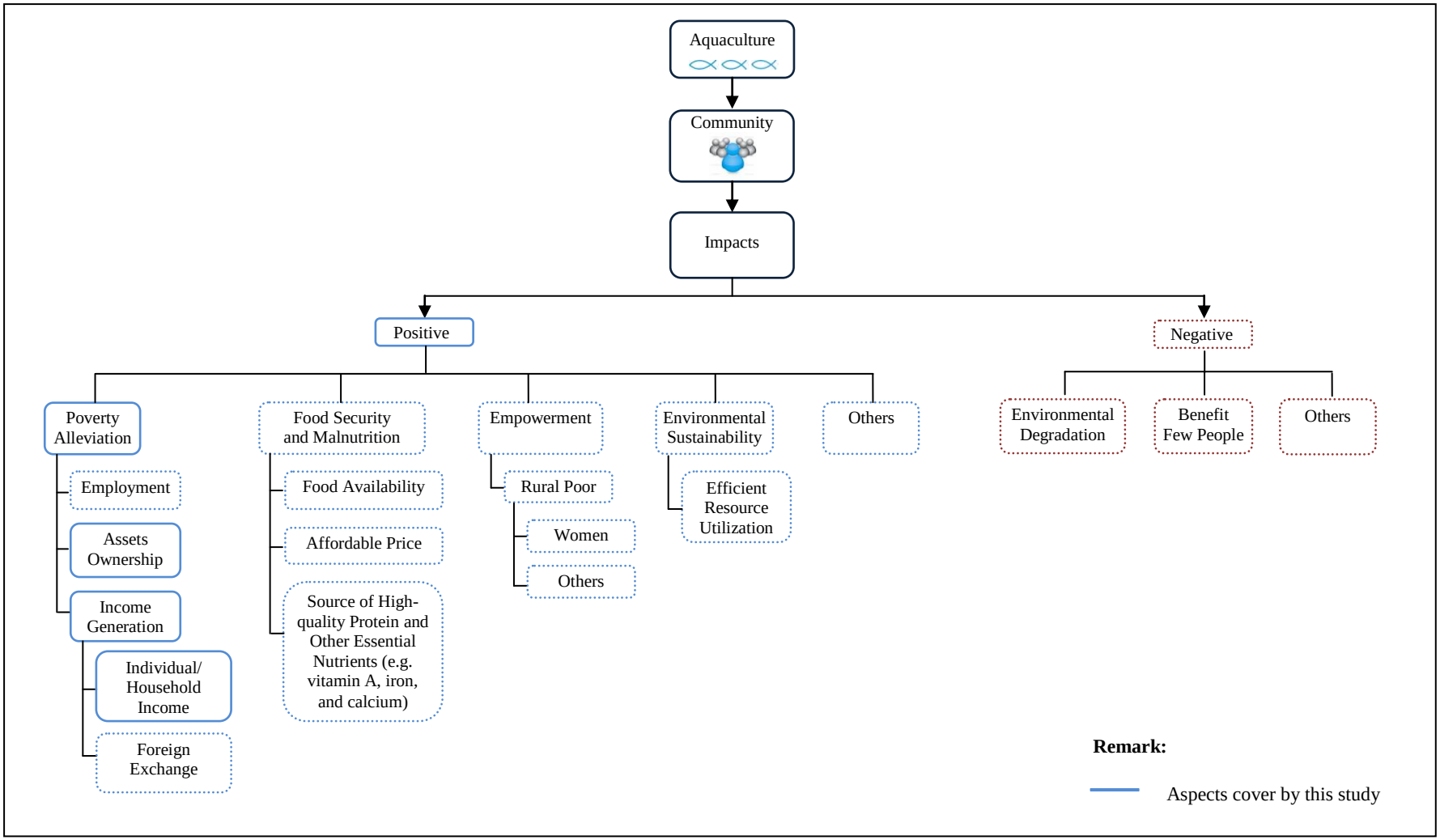


Figure 1. Linkage of Aquaculture to Development Aspects of Individual and Community (Author, 2013)

et al, (2008) and WorldFish (2011) shows that the Integrated Aquaculture-Agriculture (IAA) practice in Malawi has the following mean benefits:

1. Improving total farm productivity by 10%;
2. Increasing per hectare farm income by 134%;
3. Increasing total farm income by 61%;
4. Increasing technical efficiency by 40%; and
5. Increasing household consumption of fresh fish by 208% and dried fish by 21%.

Moreover, the IAA practice generates positive effects to the environment as it reduces nitrogen loss due to efficiency improvement (Dey et al., 2007 as cited by Russel et al., 2008). It also elevates social status for some IAA households in their communities, which is reflected by their greater access to better land and water resources as well as becoming the role model and advisor in IAA program (Russel et al., 2008).

Despite the controversy, aquaculture impacts on poverty alleviation and other development issues may be different in each location. It depends on various aspects, such as location, resource management, institution, policy, regulation and law enforcement including time of research. The empirical finding of this study would enrich the insights about the issues particularly on household income generation as shown in Figure 1.

2.3 Factors that Determine Individual Participation in the Project

One of the key successes for project implementation is the participation, and in most cases, it is related to adoption of innovation or technology that introduced in the projects. Factors affecting participation in the project have been widely studied (e.g. Lashgarara and Saharkhiz, 2012; Lynch and Lovell, 2001; Nagubadi et al., 1996; Siebert et al., 2006; Sindato et al., 2008; Zbinden and Lee, 2005) as well as study to determine factors affecting adoption (e.g. Feder et al., 1985; Kabunga, 2011; Kapanda et al., 2003; Amlaku et al., 2012).

Rogers (2003) mentions that the adoption of technology depends on the socioeconomic characteristics, preferences, and communication behavior of

individual as well as technology and environments where individual adopt the technology. He also argues that early adopters are usually wealthier, more educated, have higher social status, and greater degree of upward social mobility than the late adopters. Pollock (2005) discovers an interesting finding that is contrast to Roger's theory of adoption when she studied about the integration of aquaculture with irrigation system in two Sri Lanka's villages. Despite small number of respondents, she finds that education and wealth do not have any relationship between adopters and non-adopters in cage-based tilapia fattening project, while other factors such as social capital, proximity to cage location, and the level of ease in obtaining fish for stocking are important factors to such adoption.

Another interesting finding in Pollock's study (2005) is the reasons behind discontinuation of adoption in both villages. She analyzed it using qualitative method. In Usgala Siyambalangamuwa village, where all adopters are male, the reasons that cause discontinuation of doing cage-based tilapia fattening activity are participant involvement in other activities, cage deterioration (technical constraint), and difficulty to obtain fish for stocking. While in Rajangana village, there are male and female adopters. Both of them who fail to continue the adoption have different answers. For male adopters, unsuitable cage location, involvement in other activity, and discouragement by initial mortality are the reasons of discontinuation, meanwhile female adopters are challenged by their inability to catch fish for stocking by themselves, no help from other household members, and discouragement by initial mortality. She also reveals that the cage-based fattening tilapia adoption in both villages failed to achieve significant impact on household income security, even though it is helpful in providing emergency fund for urgent household expenses (Pollock, 2005).

Other studies specifying other factors that influence aquaculture adoption are personal characteristics (sex and age), assets ownership (Kapanda et al., 2003), physical potential, local demand for consumption and marketing (Dey et al., 2008), extension information and access to information (Russel et al., 2008), imitation of other successful farmers, knowledge, accessible training, as well as

institutional and policy environment (Pouomogne and Pemsl, 2008). The study of Lashgarara and Saharkhiz (2012) mentions that economic factors and working experience are two influencing factors of aquaculturist participation in extensional education courses in Fars province, Iran.

Two classical quantitative methods to determine participation or adoption are probit (Amlaku et al., 2012; Holloway et al., 2002; Nagubadi et al., 1996; Rahm and Huffman, 1984) and logit (Kapanda et al., 2003; Zbinden and Lee, 2005). Combination of the two and other methods are also used such as probit and average treatment effect (Kabunga, 2011), probit and tobit (Ghadim et al., 2005). Other methods that are also possible are discriminant analysis (Yapa and Mayfield, 1978) and contingent valuation analysis (Stone et al., 2008). However, probit and logit are more preferable for analyzing adoption decisions compared to discriminant analysis (Feder et al., 1985) because they are more statistically robust in practice and easier to use (Lea, 1997).

Probit and logit models are specifying a functional relational between the probability of participation in a project/adoption of technology, as qualitative binary variable on the left hand side, and various explanatory variables on the right hand side (Feder et al., 1985). Both model give substantially similar result in many cases (Cameron and Trivedi, 2010), thus the decision to choose the model is a matter of preference specifically for small data sets. In this study, probit model is chosen to determine factors that influence individual participation on sea farming project.

3. Methodology

3.1 Study Site, Data, and Survey Design

The selection of the study site was purposeful rather than random. Panggang Island is selected as it is the only successful sea farming project in Indonesia since other projects failed to be implemented due to the lack of local government support. The location of Panggang Island is shown on Figure 2. It is located around 45 kilometers from Jakarta and it needs about 60 to 120 minutes by middle-speed boat. There are 13 islands in the Panggang Island village and only two islands are populated with 5,123 inhabitants (BPS KAKS, 2011). The two populated islands are Pramuka Island as the capital city of KAKS, and Panggang Island as the most populated island in the region.

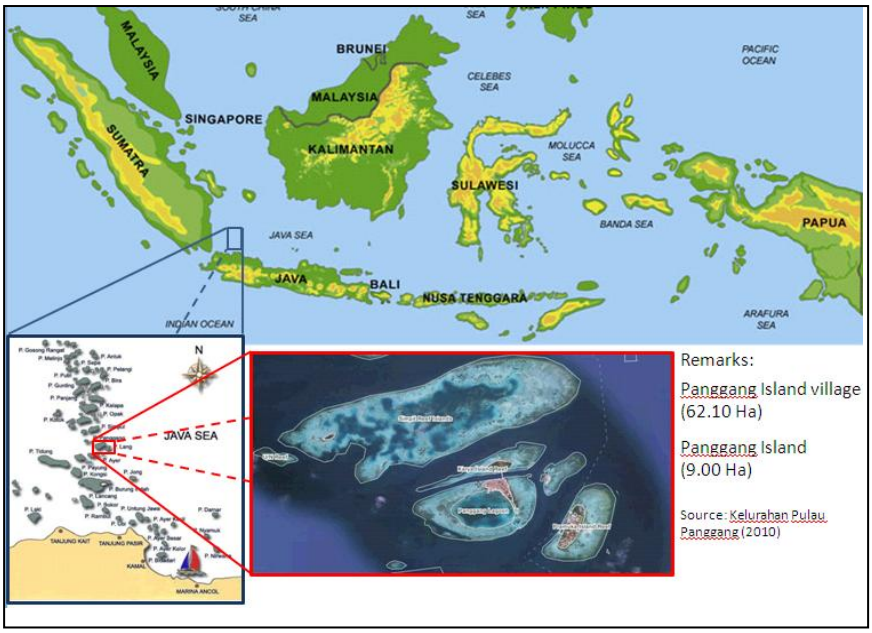


Figure 2. Map of Panggang Island, Kepulauan Seribu Administrative Regency (Kelurahan Pulau Panggang, 2010)

This study is categorized as ex-post study because the observations were conducted after the event is completed. Both primary and secondary data were used in this study (Table 3). The primary data was based on a survey of rural coastal households in Panggang Island since all sea farming members live on this island.

Table 3. Types and Sources of Data

No	Type of Data	Detail	Source
1	Primary Data	a. Respondent characteristics (e.g. age, gender, origin, education, occupation, household size). b. Mariculture activity (e.g. ownership, experience, commodity, technique, cost of production, access to credit). c. Sea farming (e.g. awareness, membership information, sea farming benefits and constraints). d. Household assets ownership (e.g. housing ownership, water supply, sanitation, electronics, and vehicles). e. Household income and expenditure.	Interview with treatment and control groups.
2	Secondary Data	a. Demographic b. Socioeconomic condition c. Market potential d. Others	a. CCMRS b. Local government (regency and province) c. Ministry of Marine Affairs and Fisheries d. BPS (statistical agency) e. FAO f. Others

The first author and enumerators administered the pretested structured questionnaire to sample household, which domiciled on 3 *Rukun Warga* (RW) and 21 *Rukun Tetangga* (RT)[7] in Panggang Island. The survey was conducted in August 2012 and total of 82 households were interviewed. It consists of 39 sea farming members as the treatment group while the control group consists of 43 non-participants. However, there are only 77 households that are composed of 34 and 43 households for treatment and control groups respectively used in the analysis because of missing values for some variables.

A random sampling strategy was employed to select both groups with different approach. The treatment group was selected using the list of sea farming members given by project's field facilitator and it only selected the active members. Meanwhile, the control group was selected by visiting them to their house[8]. The data and information drawn from this survey were used to analyze the factors that influence sea farming project participation, project impacts to local community welfare, as well as benefits and constraints to the project.

[7] RT and RW are two lowest zones under village level in Indonesia, but it does not included in the official division of Indonesian government administration.

[8] Four persons are involved in the field research and each of us interviewed at least 10 persons in 5 RT for control group, while selected sea farming participants have been determined using the list from CCMRS' field facilitator. It takes approximately 20-30 minutes to interview one respondent, on average.

3.2 Data Analysis

The first two research questions were analyzed using statistical techniques that are described with more detail in section 3.2.1 and 3.2.2. The raw data from the survey were processed using Microsoft Excel and Stata 11. In contrast with the first two research questions, benefits and constraints of sea farming for local community were analyzed by using descriptive analysis. This part is intended to explore households' and local community's points of view about sea farming project and its impacts. Along with the result of the first two quantitative analyses, this part is expected to provide some valuable insights for concluding and formulating useful policy implications related to sea farming.

3.2.1 Model Estimation for Factors that Determine Individual Participation in Sea Farming

Factors affecting project participation were examined using probit[9] model. First, we define an unobservable utility index I_i (or "latent variable") which represents the preference of the *i*-th individual to participate and is expressed by:

$$I_i = \beta_0 + \beta_i x_i \tag{3.1}$$

Second, we relate the index with the actual decision to participate in the project. We denote $Y = 1$ if household participates in the project and $Y = 0$ otherwise. Then, we assume that there is a threshold level of the index, I_i^*, such that if I_i exceeds I_i^*, the household decides to participate and vice versa.

$$\begin{aligned} Y_i = 1 &= x_i'\beta + e_i \;\; if\; x_i'\beta + e_i > I_i^* \\ &= 0 \qquad\qquad if\; x_i'\beta + e_i \leq I_i^* \end{aligned} \tag{3.2}$$

The probability that I_i^* is less than or equal to I_i can be computed from the standardized normal cumulative distributive function (CDF) as follows:

$$P_i = P(Y = 1|x) = P(I_i^* \leq I_i) = P(Z_i \leq \beta_0 + \beta_1 x_i) = F(\beta_0 + \beta_1 x_i) \tag{3.3}$$

[9] The equation and explanation about probit model is taken from Dougherty (2001); Gujarati and Porter (2009).

In other words, $F(Z)$ as the standardized normal CDF gives the probability of the event occurring for any value of Z which is expressed as:

$$P_i = F(Z_i) \tag{3.4}$$

Then, we obtain estimates of the parameters by using maximum likelihood analysis. The marginal effect of x_i is $\frac{\partial p}{\partial x_i}$ is computed as:

$$\frac{\partial p}{\partial x_i} = \frac{dp}{dZ}.\frac{\partial Z}{\partial x_i} = f(Z).\beta_i \tag{3.5}$$

Since $F(Z)$ is the cumulative standardized normal distribution, its derivative, $f(Z)$, is the standardized normal distribution and is formulized as:

$$f(Z) = \frac{1}{\sqrt{2\pi}}.e^{-\frac{1}{2}Z^2} \tag{3.6}$$

The empirical model of sea farming participation is derived from utility maximization function as adapted from Rahm and Huffman's adoption model (Rahm and Huffman, 1984):

$$U_{ti} = \alpha_t F_i(H_{ti}\, M_{ti}) + e_{ti} \tag{3.7}$$

$$\text{where} \quad t = 1,0; \quad i = 1, \dots, n$$

The underlying utility function, U_{ti} , ranks the preference of *i*-th individual participation depends on H_{ti} and M_{ti}. H_{ti} is a vector of personal attributes and M_{ti} is a vector of management characteristics that associated with a particular program[10].

In this study, personal attributes are represent by household characteristics (e.g. age, education, and occupation) and household assets ownership (e.g. boat and mobile phone ownership). Household characteristics are common factors in analyzing factors to determine project participation/adoption (Amlaku et al., 2012; Kapanda et al., 2003; Nagubadi et al., 1996). Mariculture activity, as the main project activity, represents the management characteristics.

[10] Detail explanation of the model can be seen on Rahm and Huffman (1984).

Therefore the empirical model of sea farming is described as a function below:

$$SFP = f(HC, MA, HA) \quad (3.8)$$

The dependent variable, sea farming participation (SFP) is dichotomous between 1 if respondent is participating in sea farming and 0 otherwise. The independent variables were organized into three groups, i.e. household characteristics (HC), mariculture activity (MA), and household assets (HA). The definition of all independent variables along with its coefficients' expected signs are presented on Table 4.

Table 4. Definition of Independent Variables for Determinants of Sea Farming Participation

No	Variables	Definition	Expected Sign
A.	**Household Characteristics**		
1	Age	Age of household head in years.	Positive
2	Education	Education of household head. 1= If household head attend more than nine years of education 0= Otherwise	Positive
3	Occupation	Primary occupation of household head. 1 = Fishermen 0 = Others	Positive
4	Household size	Size of the household.	Positive
5	Organization member	Social network of household head, whether he is a member of any organization other than sea farming. 1 = Household head join any organization other than sea farming 0 = Otherwise	Positive
B.	**Mariculture Activity**		
6	Mariculture experience	Mariculture experience of household head in years.	Positive
C.	**Household Assets Ownership**		
7	Boat ownership before 2005	Number of boat owned by the household.	Negative
8	Mobile phone ownership before 2005	Number of mobile phone owned by the household.	Positive

First, the independent variables that are classified as household characteristics are age, education, occupation, household size, and organization member. *Age of the household head* is expected to have positive influence on the decision to participate in sea farming. The older the age of the household head, the more likely he decided to join the project as it gives alternative to do less fishing activity which is more risky and uncertain.

Educational status of the household head provides a dummy measure of whether the household head attend less or more than nine years of education. In Indonesia,

there is a program called "*Wajib Belajar 9 Tahun*" which means all citizens should obtain minimum nine years of formal education that combine six years in elementary school and three years in junior high school. This study assumed that if one attended senior high school or university, then one would have broader knowledge and skills compared to others who only attend nine years of education or less. Therefore, it is hypothesized that educational status has positive influence on participation in sea farming project as it is classified 1 if the household head has had more than nine years of education.

Occupation of the household head provides a dummy for household head primary occupation. It is categorized as fishermen (equal to 1) and non-fishermen (equal to 0). It is assumed that one who works as fishermen will be more likely to participate in sea farming project as it gives alternative to diversify source of income. Mariculture activity would be one way to mitigate risk in face long monsoon when it is impossible for them to go fishing.

Household size measures the size of the household. It is assumed that if one has bigger household size, then the more likely one decides to participate in sea farming project as one has to obtain alternative source of income to fulfill the basic needs of other household members. It is hypothesized that household size would positively correlate with the participation decision.

Organization member provides dummy to capture whether the household head is actively participating in any organization other than sea farming. We assume that household head who actively participates in any organization would have more information including about new project or technology, therefore it is hypothesized that membership in any organization has positive influence on participation in sea farming project.

Second, the independent variable which is classified as mariculture activity is mariculture experience of household head . *Experience* in doing any mariculture activity is expected to be positively correlated with decision to participate in sea farming project. It is assumed that one who has basic knowledge about mariculture is more likely to join the program as it gives some facilities particularly in providing the fingerling. Other variables such as mariculture

ownership and number of cage nets own is not included in the model as it creates endogeneity problem. Both variables are possible to be the effects of participation in sea farming project.

Third, this study also includes variables that indicate possession to some assets such as boat and mobile phone ownership. These two continuous variables are measured before participation (using year 2005 as a threshold as it is the beginning of the project). *Boat ownership* is selected in this model as it is one of productive assets in capture fisheries activity. Boat ownership is hypothesized as negative to the decision of participation in sea farming project. If one possess boat, then it is more likely that one would have more chance to do fishing more often and feel more secured in doing daily fishing activity.

In opposite to boat ownership, possession of *mobile phone* is hypothesized as positive to the decision to participate in sea farming project. It is because by having mobile phone, one's ability to communicate with others is higher and its probability to obtain information is higher than the one who does not own any mobile phone.

3.2.2 Model Estimation for Sea Farming Impacts on Household Income and Poverty

Impacts of sea farming on household income and poverty were examined by using OLS regressions of the difference between outcome variable on both treatment and control groups. The formula is express below:

$$Y = O_{a2} - O_{02} \tag{3.9}$$

Y is the difference between the outcomes, O_{a2} for treatment group and O_{02} for control group. The model specification is given by:

$$Y = \beta_0 + \beta_i x_i + u_i \tag{3.10}$$

The definition of independent variables is described below:

Table 5. Definition of Independent Variables for Sea Farming Impact on Household Income

No	Variables	Definition	Expected Sign
A.	**Household Characteristics**		
1	Occupation	Primary occupation of household head. 1 = Fishermen 0 = Others	Positive
2	Organization member	Social network of household head, whether he is a member of any organization other than sea farming. 1 = Household head join any organization other than sea farming 0 = Otherwise	Positive
B.	**Mariculture Activity**		
3	Mariculture experience	Mariculture experience of household head in years.	Positive
C.	**Household Assets Ownership**		
4	Mobile phone ownership after 2010	Number of mobile phone owned by the household.	Positive
D.	**Sea Farming**		
5	Sea farming participation	Participation in sea farming project. 1 = Participants 0 = Non-participants	Positive

Occupation is a dummy variable which is 1= for fishermen and 0= for otherwise. Being fishermen is hypothesized to have positive relation to total income as it is one of the components in calculating total income. *Organization member* is also a dummy variable which holds 1=for member of any organization other than sea farming and 0=otherwise. It is hypothesized that it has positive relationship with total income as participating in any organization gives the opportunity to get new information for increasing household income. *Mariculture experience* is hypothesized as to have positive relationship with total income. By having experience in mariculture, one is supposed to be able to manage the activity. *Mobile phone ownership after 2010* is hypothesized as having positive relationship to total income as it could be source of information for alternative income opportunities. *Sea farming participation,* which is the main issue in this study, is hypothesized to have positive relationship to household total income. By joining sea farming organization, it is expected that it could give an alternative source of income to local community. The descriptive statistics and model estimation result are presented in chapter 4.

3.3 Limitations

Mariculture activity is the focus of this study; other activities such as capture fisheries, post-harvest, marketing, and eco-tourism, are excluded. In calculating income and expenditure, it uses period of brown marbled grouper's culture because not all aquaculturists in Panggang Island are cultivating humpback grouper due to several reasons, i.e. more limited fingerling stock, more expensive and more complicated to treat. Therefore, one period refers to brown marbled grouper culture period which is nine months.

Other limitations of this study are:

1. It does not have baseline survey for more accurate before-after comparison. It uses a recall method for several household asset ownership variables to provide information of pre-project situation of both groups (treatment and control).
2. It has times and resource constraints, hence it selected internal control group for the comparison between participants and non-participants. The advantage of internal control group is they are exhibiting more identical characteristics to the beneficiaries compares with external control group. There might be spillover effects from the beneficiaries to the control group as they are living on the same island. Nevertheless, we did not consider spillover effect in this study.
3. It does not considered any other treatments that local community received from other institutions.

4. Results and Discussion

4.1 Grouper Culture Activity in Panggang Island

Local community in Panggang Island has been practicing mariculture for more than a decade ago. The common mariculture activity in Panggang Island is shown on Table 6. From the table, we can see that grouper culture ranked as the highest compare to other species. Two common grouper that is cultured in Kepulauan Seribu are brown marbled grouper and humpback grouper, also known as polka dot grouper (Appendix 1). The difference between the two is presented on Table 7.

Table 6. Number of Mariculture Activity in Panggang Island Village (2009)

No.	Species	Number (units)	Owner
1	Seaweed	20	Local community
2	Milkfish	130	Private/local community
3	Grouper	180	Private/local community
4	Coral transplantation	32	Private/local community

Source: Kelurahan Pulau Panggang (2010)

Table 7. Characteristics of Brown Marbled Grouper and Humpback Grouper

No.	Species	Latin Name	Egg Diameter (μm)	Larval Duration (day)	Market Size (g)	Maximum Length (cm)
1	Brown Marbled Grouper	*Epinephelus fuscoguttatus*	840	35-40	0.6	120
2	Humpback Grouper	*Chromileptes altivelis*	890		0.5	90

Source: Stickney (2000)

Most commercial grouper are raised from juvenile, either from wild[11] or hatchery, and are farmed using cage or pen culture (Appendix 2). The minimum size to begin to grow-out is about 7 to 10 cm and the typical market size is about 500 to 1,000 g per fish. It needs around nine months to culture brown marbled grouper and around fourteen to eighteen months for humpback grouper. The grouper are fed using trash fish and fish pellet.

Rahayu (2008) found some bacteria and parasites on the grouper in Panggang Island village farms. Bacteria which usually infected are *Vibrio* sp. 1 and *Vibrio* sp. 2, while some parasites which founded are *Myxosporea*, *Trichodina*,

[11] Wild juvenile grouper is caught using *bubu*, a type of traditional portable trap.

Metacercia, and *Diplectanum*. The common method that the aquaculturists used to prevent the diseases is by washing the fish using fresh water once in a week for juvenile fish (size 3 to 15 cm) and once in a month for bigger fish (size 17 to 20 cm). They usually collect rain water for this purpose. While to treat the infected fish, over-the-counter drugs (OTC) for human were used by a small number of aquaculturists. For example, antiseptic is used to cure ulcer fish.

In total, production of grouper in Panggang Island village reached 18,441 in 2009 (BPS KAKS, 2011). That is the highest compare to other villages in the same district (Kepulauan Seribu Utara district). The aquaculturist sold their production to middlemen (*palele*) or directly to the trader at fish market in Muara Angke, Jakarta.

Grouper culture is becoming more popular as some private companies started their business in the region and then the local government introduced it to the community. Unfortunately, most of the projects failed because of low-quality fingerling; improper aquaculture technique; no extension service; no clear rules; and project based on local government interest only (CCMRS, 2008).

In Panggang Island village, there are three areas for grouper culture which are territorial waters near Panggang Island, Semak Daun Island, and Karang Congkak. Most of the respondents grow their grouper in Panggang Island and Semak Daun Island (Figure 3). All non-participants farmed their grouper in Panggang Island because Semak Daun Island is exclusively for sea farming project participants. Nevertheless, there are more than half of participants (68%) who are doing its mariculture activity near Panggang Island because it is closer to their residence.

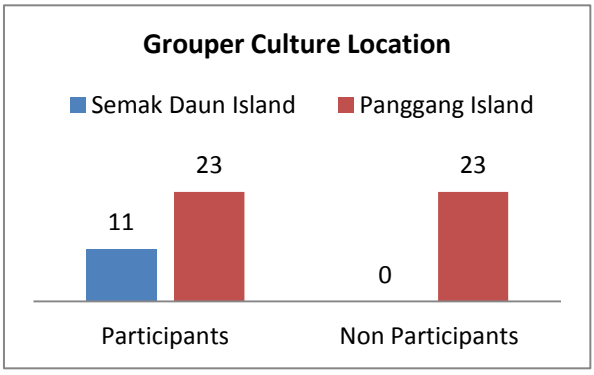


Figure 3. Grouper Culture Location of Respondents (Author, 2013)

In term of mariculture technique, almost all respondents (93%) prefer to use cage culture than pen culture to grow the fish (Figure 4). Only two persons for each groups decided to use pen culture. Grouper culture in Panggang Island is a male-dominated activity. The role of women in this activity is very limited to help their spouse in fish-washing activity.

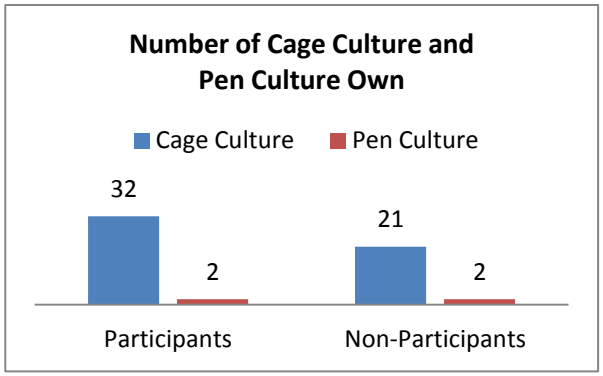


Figure 4. Number of Cage and Pen Culture of Respondents' Owned (Author, 2013)

4.2 Sea Farming in Panggang Island

In this section, we describe information related to sea farming project in Panggang Island before further discussing about the survey results and model estimation. This section would help to understand the basic concept and description of sea farming project.

4.2.1 The Basic Concept

Sea farming project in Panggang Island was adopted from sea ranching in combination with community-based agribusiness system's concept. Sea ranching has being practiced in Norway, United States and Japan since the 17th century. Sea ranching is defined as the activities to produce fish seed and release it—in a form of egg, larvae or juvenile—to the sea in order to recapture the fish for fishery production as well as increase the fish population (Effendi, 2006). Most common sea farming systems are based on artificial reefs (e.g. India and Taiwan) and cage nets (e.g. China, Japan).

Sea farming is different from mariculture although it is perceived as similar phenomena by the local community. Indeed, mariculture is the main activity in sea farming project. The idea of creating the project was to give an alternative source of income to the local community particularly for the ones who work on SSF sector. Therefore to ensure successful implementation of sea farming project, CCMRS involved local government along with local community, and other stakeholders in designing the sea farming institution and its operational rules. This collaboration of all stakeholders was expected to become a successful co-management institution in managing marine ecosystem as the CPR (Adrianto, 2011).

Other reasons behind sea farming project is to increase fish population (stock enhancement) in the marine ecosystem. The local fishermen complained that their fishing productivity was decreasing; therefore restocking activity is urgently needed to conserve the marine ecosystem.

Sea farming project was designed as a system composed from three sub-systems, i.e. input, process, and output. Figure 5 presents the concept of sea farming institution. The first sub-system is the supporting factors for mariculture activities in the second sub-system. In first sub-system, demarcated fishing rights were created using the result of preliminary study of geophysical and oceanography as well as participatory research (CCMRS, 2006). It determines territorial waters around Semak Daun Island as sea farming demarcated fishing rights (Figure 6), this area was selected because it has protected shallow open sea area as shown in Figure 7. The agreement also determines the appropriators who can utilize the right to use of the agreed area. This right is not a property right and is non-tradable.

The second sub-system is the heart of the project since economic input and output of the project come from this sub-system. From Figure 5, we can see that mariculture activity is starts from the hatchery, fry-rearing to grower. Local community was encouraged to involve on all activities in the second sub-system, so the direct and indirect economic benefit of the program will give positive effects to the local community. In practice, most of the aquaculturists (participant

and non-participant) in Panggang Island were focus on grouper's rearing or growing, while the local hatchery[12] and fry-rearing is not well-established yet. There are local hatcheries in the region but it is not able to produce a good-quality grouper fingerling, and therefore CCMRS provide the fingerlings from external hatchery. They will raised it until it reach about 7 to 10 cm in size on sea farming center before distribute it to the members. The last component is sub-system output and it covers distribution, marketing and conservation (CCMRS, 2006).

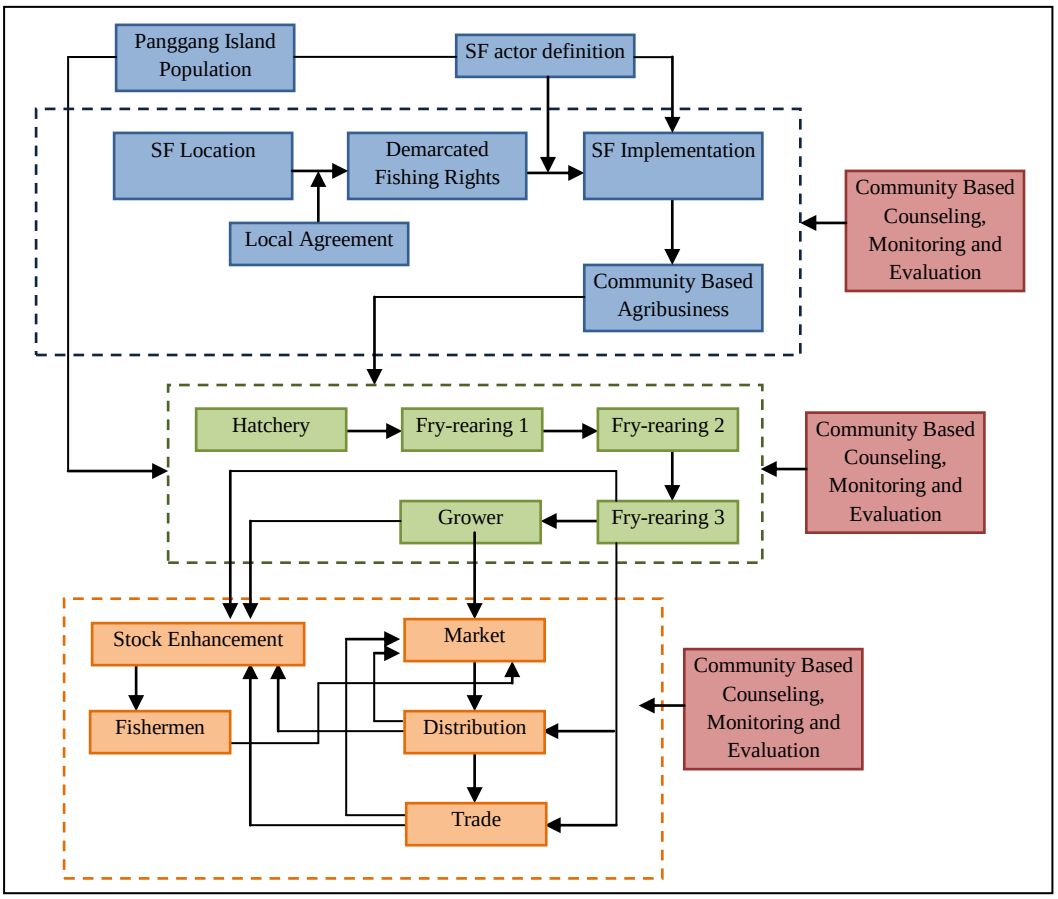


Figure 5. Concept of Sea Farming Institution (CCMRS, 2006)

[12] Local government built a local hatchery at Tidung Island, a part of Kepulauan Seribu Selatan district. It is established since 2008, but no significant contribution for local community because it does not function well.

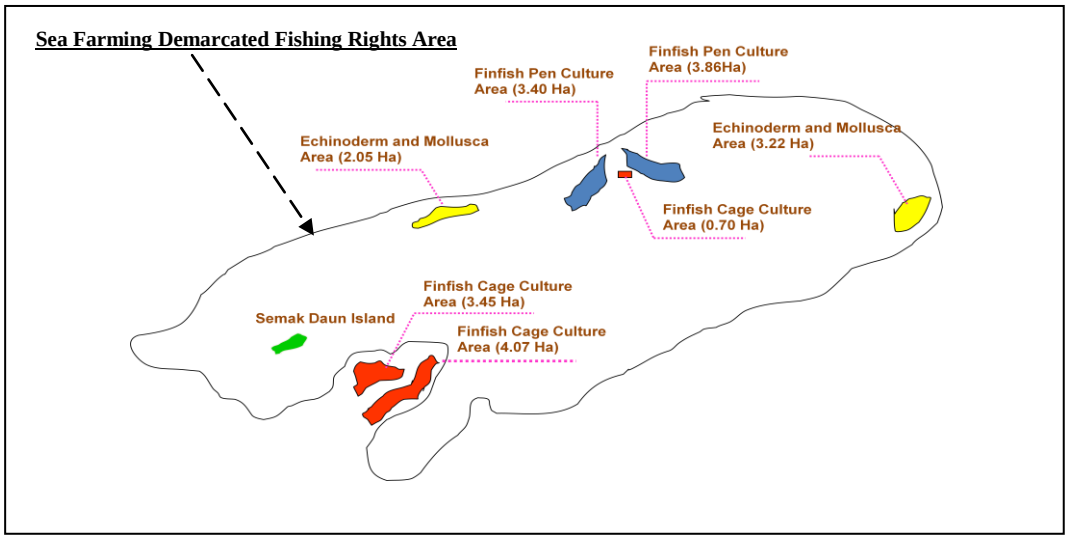


Figure 6. System and Location for Mariculture Activity in Semak Daun Island (CCMRS, 2006)

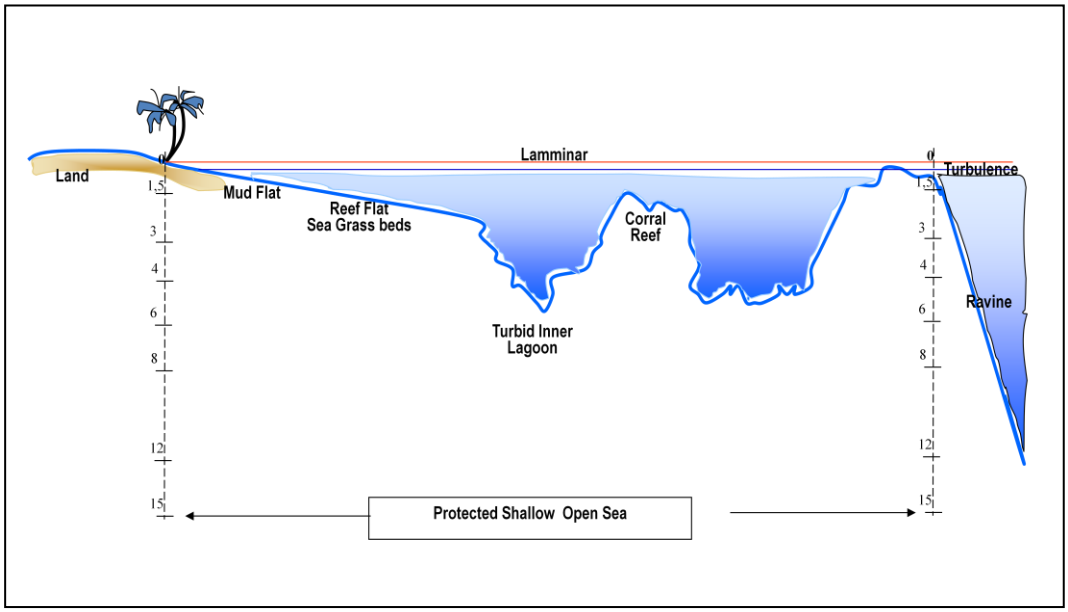


Figure 7. Protected Shallow Open Sea in Semak Daun Island (CCMRS, 2007)

4.2.2 The Project Description

Sea farming project is developed to empower rural coastal community while sustaining the environment. The project was mainly funded by local government of Kepulauan Seribu Administrative Regency and CCMRS. The target beneficiaries are fishermen and aquaculturists because small-scale fishermen in Indonesia are vulnerable to become poor since they are exposed to high risks and uncertainties. The project was organized by CCMRS and the project's beneficiaries are organized into one group. This organization is self-managed by the community.

The project activities are (1) setting up the regulation, institution and infrastructure; (2) provide knowledge and skill-based training; (3) provide fingerling; (4) connect sea farming member to the market; and (5) provide counseling. In its first activity, CCMRS conducted preliminary study which covers geophysical and oceanography and socioeconomics aspect to set up regulation, institution and infrastructure of the project. They also conducted rapid rural appraisal, participatory rural appraisal, and participatory action research in analyzing the institutional-building aspect and constructed operational rules for sea farming project in Panggang Island. In term of providing infrastructure, local government built sea farming hall (Figure 8a) as a place for meeting, training and other activities for sea farming member.

(a) Sea Farming Hall

(b) Training

Figure 8. Facilities and Activities of Sea Farming (CCMRS, 2007)

The second activity is providing training (Figure 8b), particularly for new members. The training would cover some modules related to mariculture

techniques and skills, managerial and entrepreneurship skills, including achievement motivation training. The third activity is providing the fingerling for the members using revolving fund mechanism. In this case, CCMRS bought fingerling from external hatchery in East Java and Bali then it is distributed to all members. Each new member who wants to conduct mariculture would get 200 fingerlings as the project loan. They have to repay the loan if they finally succeed to harvest the fish. The amount of loan is dependent on the price and size of the fingerling. For example, they usually get 10 cm fingerling and the price of the fingerling is around IDR 1,300/cm. It means they have to return the loan of IDR 2,600,000 (counted from 200 pieces x IDR 1,300/cm x 10 cm).

The members are able to up-grade their membership categories whenever they can manage to pay the loan on time. Then, they will have additional loan to buy the fingerling in the next period. CCMRS categorized the sea farming members into four different classes (Table 8).

Table 8. Sea Farming Member Classification

No	Classes	Number of Fingerlings (pieces)	Criteria
1	Platinum	800	– Already harvesting and more independent
2	Gold	600	– Already harvesting but still have some technical and non-technical constraints.
3	Silver	400	– Sea farming member and already conducting mariculture activity. – Still have some constraints in doing the mariculture.
4	*Biru*	200	– Sea farming members but not conducting any mariculture activity yet.

Source: Rangkuti (2008); Rudiyanto (2011)

As an illustration, Mr. A decided to join sea farming project in 2005. After he completes the training program he will get a certificate of membership. Then he is categorized as a "*Biru*" member. When he started his mariculture activity, he got 200 fingerlings as the project's loan. After nine months, he successfully cultured the grouper and sold his harvest. Consequently, he has to pay the IDR 2,600,000 to CCMRS. If he paid the loan soon after he sold his production, then he will get extra 200 fingerlings for the next period. Now, he had up-graded his membership to "Silver" class and receives 400 fingerlings in total for his

second year. Every time one is successful conducting his mariculture activity and his repaying the loan on time the project will give "award" through an up-grade of his membership which gives additional fingerlings as an incentive to work harder and honest.

This project also gives dispensation for its member by giving a possibility to repay the loan in installment method especially for those who have any urgent matters, such as sickness of family member and children wedding. In an extreme case, one may cheat by confessing that his fish were dead or stolen in order to get dispensation to eliminate his responsibility to pay the loan. The report then will be cross-checked with other members in the group. If he is convicted lying, then he will be punished by not getting any fingerlings on the next period. This irresponsible member usually will discontinue his membership. In this case, internal group monitoring is applied.

Besides providing fingerling, CCMRS also provides loan in form of mariculture production means, such as nets, drums and feed, on limited number. It distribution is based on sea farming committee's decision. The mechanism of repayment method is the same with fingerling's loan.

In the fourth activity, connecting sea farming member to the market, CCMRS invited buyer and trader from Muara Angke, Jakarta. This is not really effective because most of members have their own buyer. In practice, the member will sold their production directly to the buyer or middlemen whose came to Panggang Island. As an alternative, they will send their production directly to Muara Angke. The first option is preferable compare to the second option because it is less costly and easier.

Fifth activity, CCMRS provides field facilitators whom responsible for giving assistance/counseling of any technical and non-technical issues and also managing the loan. Only if the member faced any serious problems, such as diseases in larger scale, the dedicated aquaculture expert from CCMRS would come and check to make any necessary treatment.

Restocking is other activity which should be attached to sea farming project because it is the means to reach its second objective, conserving the marine ecosystem through stock enhancement. Formally, the agreement between local government, CCMRS and sea farming members regulate that every member should contribute 5% from their production for restocking purpose. In practice, the regulation cannot be successfully implemented yet because lack of fingerlings stock. Therefore, no official restocking activity is conducted by sea farming member yet. There are two restocking activities in 2010 which used fund from the Ministry of Environment, Republic Indonesia and CNOOC[13].

Restocking is perceived as an important issue by more than half of respondents (56%). Figure 9 shows the proportion of respondent's perception to restocking issue. The reasons behind the importance of restocking in respondents' point of view are: (1) to increase fish population; (2) to sustain the environment for current and next generation; (3) to sustain economic activity as the number of population is growing while number of fish is declining; and (4) to support fishing activity.

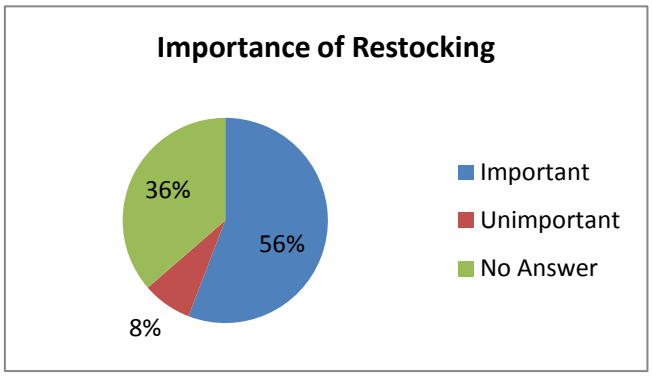


Figure 9. Proportion of Respondent's Perception to Restocking (Author, 2013)

In general, the basic idea and concepts of sea farming project is good. It is combining some important aspects of economic development for rural coastal community, for example empowerment, agribusiness, and environment conservation. However, the project still faces some constraints which is hampering its potential to contribute for welfare increase as expected. The next section analyzes factors that determine sea farming participation and its impact on

[13] CNOOC (China National Offshore Oil Corporation) is one of the foreign offshore oil companies that operated in Indonesia. CNOOC involvement in restocking activity is part of its CSR's program.

the community (section 4.3), while later section describe about benefits and constraints of sea farming implementation (section 4.4).

4.3 Estimation Result

4.3.1 Descriptive Statistics of Sampled Household in Panggang Island

Descriptive statistics of sampled households are shown in Table 9. On average, the sea farming project participants are older in age compared to non-participants. The average age of participants is 40 years old, while non participants' average age is 36 years old. The mean difference between both groups is significant on 10% level of probability.

The participants are represented by a lower percentage of respondents who attend more than nine years of education (on average 2.94% compare to 23.25%), though the number of respondents who attend less or equal to nine years of education are the same for both groups (33 respondents each). There is only one respondent who attended more than nine years of education in participant group compare to ten respondents in non-participant group.

The percentage of respondents whose occupation is fishing is higher for non-participants (93.02%), and obviously percentage of respondents whose owned mariculture activity is higher for participants (100%) as well as its mariculture experience (on average 4.97 years for participants compare to 3.62 years for non-participants). Likewise, participants have higher percentage of number of cage nets ownership (7.41 cages per participant compare to 4.19 cages per non-participant).

In terms of household size, there is no significant different between both groups. The average household size for both groups is four members. For household assets ownership characteristics, such as housing and mobile phones; there is no significant difference between participants and non-participants. One quite interesting point is the boat ownership between groups. Although less participants work as fishermen, participant group tend to own more boats, on average, compare to non-participant group (55.88% versus 32.56%). The difference between both groups is statistically significant.

Table 9. Mean Comparisons of Sampled Participants and Non-participants

Variables	Participants (n = 34)		Non-participants (n = 43)		Total (n = 77)		Difference
	Mean	SD	Mean	SD	Mean	SD	
A. Household Characteristics							
Age (years)	40	11.0179	36.0932	9.9422	37.8182	10.5428	-1.6127*
Education (1/0)	.0294	.1715	.2325	.4275	.1429	.3522	2.8406***
Occupation (1/0)	.7059	.4625	.9302	.2578	.8312	.3771	2.5343***
Household size (members)	4.4412	1.1333	4.7907	1.5049	4.6364	1.3564	1.1622
Organization member	.0294	.1715	.5116	.5058	.2987	.4607	5.8416***
B. Mariculture Activity							
Mariculture ownership (1/0)	1	0	.5349	.5047	.7403	.4414	-6.0433***
Mariculture experience (years)	4.9709	.9688	3.6279	3.8361	4.2208	2.9983	-2.2079**
Number of cage net (numbers)	7.4706	3.0474	4.1860	4.9917	5.6364	4.5274	-3.5571***
C. Household Assets Ownership							
Housing ownership (1/0)	.8235	.3870	.7674	.4275	.7922	.4084	-0.6029
Boat ownership before 2005 (units)	.5588	.5040	.3256	.5657	.4286	.5484	-1.9099**
Mobile phone ownership before 2005 (units)	.3824	.5513	.3256	.6444	.3506	.6019	-0.4163
D. Household Income and Expenditure							
Total income (IDR/period)	3.52e+07	1.71e+07	2.87e+07	1.51e+07	3.16e+07	1.62e+07	-1.7331**
Total expenditure (IDR/period)	2.65e+07	9540809	2.54e+07	1.37e+07	2.59e+07	1.20e+07	-0.3997

Source: own calculation

Notes: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.

The null hypotheses to compare means difference of both groups is defined as H_0: $\mu_{\text{non-participant}} - \mu_{\text{participant}} = 0$.

Social network in this study is exposed by capturing whether or not respondents belong to any organizations except sea farming. The descriptive statistics analysis shows that non-participants claim to have higher percentage (51.16%) of participation in any other organization compare to participants (2.94%).

For income, participants have significantly higher income compare to non-participants (IDR 35,200,000 versus IDR 28,700,000). Income in this study is calculated from the accumulation of SSF income (capture and/or mariculture) and any other sector's incomes (e.g. tourism, trade, self-employed, and labor work). Income from direct transfer, food aid, remittance from family member, assistance from relatives, or renting land/house/boats are removes from income calculation since most of the respondents are reluctant to answer such questions. Income was counted as period of nine months for both groups. The reason to use periodic income is to be able to include mariculture income in the total income calculation. As mentioned in the section 3.3, this study only considers brown marbled grouper as the main mariculture activity in Panggang Island and this type of fish needs nine months to grow until it reaches consumption size and is therefore ready to sell.

Other explanatory variables such as gender and awareness to sea farming project are excluded from the analysis as we have not observed any significant differences between both groups. All respondents are male and most of them are aware of the project. We suspect that the area of the island is quite small, therefore information dissemination is quickly spread from one person to the others.

The next section describes about estimation result of factors determining individual participation in sea farming project as well as sea farming impacts on household income.

4.3.2 The Determinants of Sea Farming Participation

Table 10 shows the probit regression of sea faming participation. The result shows that education, occupation, household size, organization member, mariculture experience and mobile phone ownership are factors that influenced the likelihood of sea farming participation.

Table 10. Determinants of Sea Farming Participation

Variables	Coefficients	Marginal Effects	Z
Age (years)	.0106	.0041	0.3000
Education (1/0)	-1.9106	-.4671	-3.7500***
Occupation (1/0)	-2.0409	-.6569	-4.150***
Household size (members)	-.5898	-.2256	-2.4700**
Organization member (1/0)	-3.7105	-.7922	-8.6600***
Mariculture experience (years)	.3514	.1345	3.0600***
Boat ownership before 2005 (unit)	.8233	.3151	1.5100
Mobile phone ownership before 2005 (unit)	.9795	.3750	1.8700*
Constant	2.9435	-	-
Summary Statistics			
Model Test (Likelihood Chi^2)	65.8300		
Prob > Chi^2	0.0000		
Pseudo R^2	0.6229		
Log likelihood	-19.9305		
Number of Observations	77		

Source: own calculation
Notes: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.

On household characteristics, age has positive influence but not significant. It means that age of the household does not influence the decision to participate in sea farming project. Education has negative influence but statistically significant at 1% level of significance. This is showing different result to the hypothesis. The model shows that if education variable change to higher level (as education is a dummy variable), *ceteris paribus*, then there will be a decrease in the probability to participate in sea farming project by 46.71%. This result is contrast to previous study on participation that mentions education has positive and significant influence to the decision of participation in the project (Zbinden and Lee, 2005). The result might be cause by having higher education level, a person will have

more skill, knowledge, networks, and options to get better occupation and income, hence the less likely he is willing to participate in the project.

Occupation also shows different result than hypothesized. Occupation has negative and is statistically significant at 1% level of significance to sea farming participation. As occupation is also a dummy variable, interpretation of the result is the probability of participating in sea farming project decrease by 65.69% for being fishermen, *ceteris paribus*. We suspect that, the habit and psychology of fishermen cause this phenomenon. Fishermen are already used to "hunting" activity to fulfill their needs, while being an aquaculturist force them to have the responsibility to grow the fish. These would need additional efforts, money, and time compared with fishing. Although mariculture's profit seems promising, it also has the risk though it might not as risky and uncertain as fishing. The difficulty to change the mind set and habit of the fishermen is also admitted by several researchers who are involved since the beginning of the project.

Household size also has negative influence and statistically significance at 5% level of significance. The model shows that an additional of one member in the household, *ceteris paribus*, would reduce the participation by 22.57%. It is supposed that the bigger the family size, the more persons in the household could become an active income earner. It also gives the possibility to have cheaper labor to do other activities, e.g. fishing, labor work.

Organization member shows the same result as education, occupation and household size. The probability of joining sea farming decrease by 79.22% for being active in any organizations at 1% level of significance, *ceteris paribus*. By joining other organizations, they are exposed with more information compare to the others who did not join any organization. There are 51.16% of the control group' members who join other organizations. Most of organization they participate is related to SSF acitivities. For example, Pernitas (*Perhimpunan Nelayan Ikan Hias dan Tanaman Ikan Hias*) is an organization for fishermen who caught ornamental fish and plant, while UPBL (*Unit Pengembangan Budidaya Laut*), Paus Biru, and Keramba are organizations for aquaculturists.

Mariculture experience has positive sign and significant at 1% level. One year increase on mariculture experience variable, *ceteris paribus*, would increase sea farming participation by 13.45%, on average. The relationship between experience and sea farming participation is obvious. One who gets used with mariculture activity will decide to participate in such project as it provides an extra fund to buy high-quality fingerlings. Confession from several sea farming members mentioned that if they do not join sea farming, then they could not afford to buy such expensive fingerlings.

Boat ownership, as one of the productive assets for fishermen, is not significant in influencing the project participation although its marginal effect shows positive sign. We suspect that boat ownership is not a crucial element in doing the mariculture activity though it will be very helpful if one has their own boat to control their cages every day.

Mobile phone ownership shows a positive influence on sea farming participation. It shows that the probability of participating in the project increase by 37.49% by an increase on one unit of mobile phone ownership, *ceteris paribus*, at 10% level of significance. It shows that mobile phone ownership is not the only means of communication but also means to spread information from one person to the others.

The goodness of fit of the model is already given by Stata. The overall model of sea farming participation has likelihood ratio chi-square of 65.83 with p-value of 0.0000. This information tells us that the model is statistically significant.

4.3.3 Sea Farming Impacts on Household Income and Poverty

In developing the model of sea farming impacts on household income using OLS regression, we define total income per period as the dependent variables. Then, we did partial regression of all independent variables from the data to analyze which variables are significantly influencing the total income. Hereupon, we executed several models to determine the best model.

Table 11 presents the best model of sea farming impacts on household income that we can obtain. The overall model shows F-test value equal to 10.98 with p-value of 0.0000. These numbers indicating that the group of independent variables shown on Table 11 can be used to reliably predict the total income. The R^2 of the model is 0.4396, which is indicating 43.96% variance in total income can be explained by the independent variables.

Table 11. Sea Farming Impacts on Household Income

Variables	Coefficients	t	P>|t|
Sea Farming Participation	4901929	1.2400	0.2170
Fishermen	-1.96e+07	-4.7800	0.0000***
Organization Member	7451221	1.8000	0.0770*
Mariculture Experience	1033860	1.8400	0.0690*
Mobile Phone Ownership After 2010	3239393	2.6300	0.0100***
Constant	3.44e+07	6.3100	0.0000
Summary Statistics			
Model Test (F-test)	10.9800		
Prob > F	0.0000		
R^2	0.4396		
Adjusted R^2	0.3996		
Root MSE	1.3e+07		
Number of Observations	76		

Source: own calculation
Notes: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.

Being fishermen decreases the total income by IDR 19,600,000, *ceteris paribus*. This is significant at 1% level and the result is contrasted to the previous hypothesis that predicted it would have positive relationship with one's total income. One unit increase in organization member, increases the total income by IDR 7,451,221, *ceteris paribus*. It is significant at 10% level and it fits to the hypothesis that organization member have positive relationship to household income. Membership in any organization facilitates the interaction with other people as well as building one's social capital and networks. It also gives the opportunity to get more information including about new technology in SSF and its market potential.

Having one year increase in mariculture experience, would increase total income by IDR 1,033,860, *ceteris paribus*, at 10% significance level. By having more

experience, one will be able to have better skills compared to beginner. For example, if one person has more experience then he would be better able to handle any issue concerning fish disease. So, one would not experience severe loss.

Mobile phone ownership is significant at 1% significance level. One unit increase in mobile phone ownership would increase IDR 3,239,393 in total income, *ceteris paribus*. This is shows that mobile phone ownership is important for those who live in rural coastal area as its mobility is lower compare to those who live in the urban and mainland area. The mobile phone ownership could be used as means to engage in any productive and profitable activities, obtain market opportunity and so on.

Surprisingly, sea farming participation is the only variable in the model that is not significant but has positive relationship with total income, while its mean difference between both groups is significantly different (Table 12). Total income of participants is higher than non participants (IDR 35,200,000 versus IDR 28,700,000) and it is significant at 5% significance level.

Table 12. Two-sample t-test with Unequal Variance for Total Income of Both Groups

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	43	2.87e+07	2297679	1.51e+07	2.41e+07	3.34e+07
1	34	3.52e+07	2924901	1.71e+07	2.92e+07	4.11e+07
combined	77	3.16e+07	1845087	1.62e+07	2.79e+07	3.52e+07
diff		-6446330	3719459		-1.39e+07	978930.3

diff = mean(0) - mean(1) t = -1.7331
Ho: diff = 0 Satterthwaite's degrees of freedom = 66.4215

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0439 Pr(T > t) = 0.0877 Pr(T > t) = 0.9561

If we combine both results between the OLS regression and t-test of two different means, it seems that sea farming project is contributing in increasing household income of participants although its not significant. The insignificant result might be cause of limited number of observations. Other things might be considered are the scale of the project, if the project could involve more participants, then it its impacts might be larger than the result shown in this study.

Besides those reasons above, there are lots of factors which can influence income that might not have been captured by this study. Other intervention from other organization/institutions for local community could also affect household income for both participants and non-participants.

4.4 Benefits and Constraints of Sea Farming

Sea farming is perceived as a project that gives positive contribution to local community as it gives the chance to have additional source of income from participants' point of view. All of participants answered to "yes" option when they were asked whether or not sea farming gives any benefits to the local community. Meanwhile only nine non-participants who agreed that sea farming benefit local community, two non-participants answered "no" and the rest do not give any answer. Figure 10 shows number of respondents and their perception of sea farming benefits.

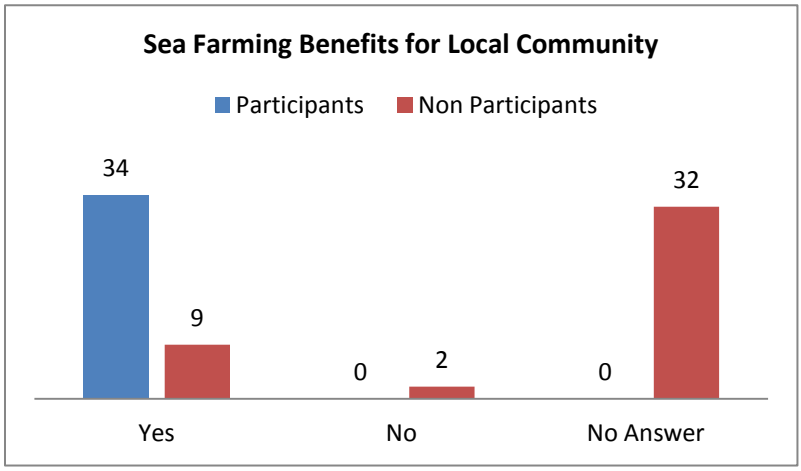


Figure 10. Participants and Non-participants Perception to Benefits of Sea Farming (Author, 2013)

The respondents (both participants and non-participants) who give "yes" answer have different reasons to this question, several responses are:

1. It gives alternative to improve household and local community's economy;
2. It enhances local community mariculture knowledge and skills;
3. It provides capital for mariculture activity;
4. It provides fingerling as the main input in mariculture activity;

5. It provides funds to fulfill needs during fasting times (*Ramadhan*) and celebrating muslim's holiday (*Idul Fitri* and *Idul Adha*); and
6. It helps to increase household assets ownership (e.g. owning house and boat).

Besides benefits to local community, this study also tried to capture the problems or constraints of the project perceived by local community particularly from participants' point of view because they are most affected from project intervention. Figure 11 presents some constraints that were faced by sea farming members. The figure shows that most of sea farming members felt that they do not have any constraints concerning capital, fingerling stocks, technical skills, and management skills because it is already provided by the project. Meanwhile, water quality and other problems such as security, diseases, delay of fingerlings supply as well as internal and external conflict.

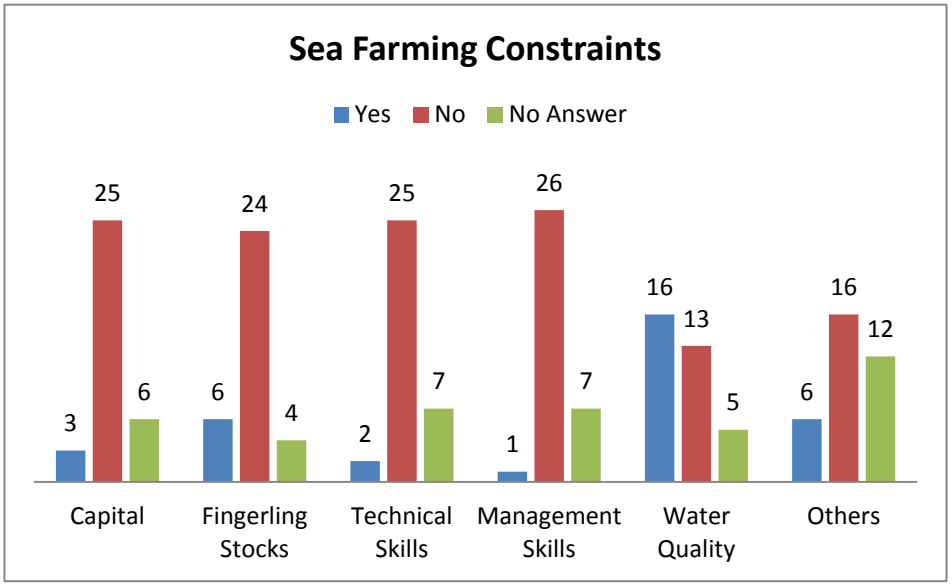


Figure 11. Sea Farming Constraints Based on Participants Perception (Author, 2013)

Security becomes more important nowadays. The frequency of fish being stolen is increasing. Therefore, aquaculturists from both groups do everyday checking to their cages, every morning and afternoon. Some people with better capital prefer to have safeguard house, so the owner could stay during the day. There are only seven individuals who owned safeguard house, four individuals from participant group and the rest from non-participant group.

One of the interesting finding is respondents' answer to the question of "What should be improved in sea farming project that would make it more beneficial to local community?". Most of respondents answered that sea farming project should open a new recruitment because there are quite lots of people who want to join the sea farming group. It means that there is an interest from non-participants to join sea farming group. New member recruitment will reduce jealousy from non-participants in the society. Other issues which are raised are quality and quantity of the fingerlings, local hatchery establishment and reinforcement to provide low-cost and high quality fingerling in a timely manner, information transparency specifically for sea farming members to reduce internal conflict. The result of this conflict is retransformation of sea farming committee in 2012.

Access to credit for local community is another interesting finding. None of all respondents get credit from any bank and other microfinance institutions. The reasons are they do not know how to apply for credit and they do not have any legality of their business. In case of lack information, socialization about credit program has been conducted every year from local government and some banks, such as Bank DKI, BNI, and BCA. Unfortunately, the program representatives did not actively socialize the program. They are only waiting someone to come to their desk asking any information about credit.

To sustain sea farming in the future, there are several things to be improved, such as better management, information transparency, and trust between sea farming committee and its members. The new committee is challenged to have better organization, so they will have good images from participants, non-participants and local community as a whole.

5. Conclusion and Policy Implications

This central focus of this study is to identify the factors which determined participation in sea farming project and to analyze the impacts of the project on household income. The data shows that some factors which significantly influenced the household decision to join the program are education, occupation, household size, organization member, mariculture experience, and mobile phone ownership. In contrast to other empirical studies that show education has positive relationship with the participation in the project (Amlaku et al., 2012; Zbinden and Lee, 2005), here we found that education decrease the probability of one to participate in the project. Individual involvement in any organization other than sea farming also decreases the probability to participate in the project, another result which differs from previous studies such as Nagubadi et al. (1996). Only two factors that show positive relationship with participation in the program are mariculture experience and mobile phone ownership. Mobile phone gives the access to information and other more profitable opportunities. It has become more important as their mobility is challenged by their location. Having mobile phone provides the chance to connect to the regional markets.

An interesting finding, when analyzing the impacts of sea farming project on household income, is that the sea farming participation has positive relationship with total income, but it is not significant. Instead the mean difference of average total income between participants and non-participants has significant difference.

Basically, sea farming is a good concept for providing economic activity for rural coastal community but the implementation still faces some constraints which have limited the impact of the project. In order to overcome these constraints the project should improve in several aspects such as:

1. Enhancing the role of local hatchery to produce good quality fingerlings. By having local hatcheries that can produce good-quality fingerlings, aquaculturist will have cheaper and higher survival rate of fingerling in a timely manner.

2. Optimize the role of bank and other microfinance institutions so that the local community is able to expand their business not only for mariculture activity but also for other activities such as fishing, processing and marketing. However, careful implementation of opening access to the credit is also necessary. Otherwise, over-harvesting of fish production will occur thereby leading to a lower price.
3. Local government should create rules about the practice of mariculture by introducing licenses to perform mariculture as it should consider the carrying capacity of the area and the distance between the cages. If the density of mariculture activity is too high than it might cause severe loss in case of disease outbreaks as in the case of Chilean salmon business crisis (Asche et al., 2009). Another problem which may occur without strict regulation is the conflict between the aquaculturists as there are more and more people interested in the activity.

With good governance, appropriate legal frameworks and strong institutions, utmost good faith from all stakeholders, the project could benefit more people in the society. To apply this type of project in the other area there should be preliminary research as different areas will have different characteristics of environment and socioeconomic aspects. By taking into account all of these aspects into a project it is expected that it could produce a win-win situation for all stakeholders.

References

Adrianto, L. (2011). "*Tinjauan Kritis Adopsi Pengetahuan Lokal dalam Pengelolaan Perikanan*". In L. Adrianto (Ed.). Konstruksi Lokal Pengelolaan Sumberdaya Perikanan di Indonesia. Bogor: IPB Press.

Ahmed, M. and M.H. Lorica (2002). "Improving Developing Country Food Security through Aquaculture Development—Lessons from Asia". *Food Policy* 27:125–141, available online: http://static.sdu.dk/mediafiles-/Files/Om_SDU/Institutter/Miljo/fame/workshop/jun05/readings/foodpolicy.pdf.

Aldhous, P. (2004). "Fish Farms Still Ravage the Sea: Sustainable Aquaculture Takes One Step Forward, Two Steps Back". *Nature Online*, 17 February 2004, available online: http://www.nature.com/news/1998/040216/full-/news040216-10.html#b1#b1>1.

Allsopp, M., P. Johnston, and D. Santillo (2008). *Challenging the Aquaculture Industry on Sustainability*. Amsterdam: Greenpeace. Available online: http://www.greenpeace.org/france/PageFiles/266559/challenging-the-aquaculture-.pdf.

Amarasinghe, U.S. and T.T.T. Nguyen (2010). "Enhancing Rural Farmer Income through Fish Production: Secondary Use of Water Resources in Sri Lanka and Elsewhere". In S.S. De Silva and F.B. Davy (Ed.). *Success Stories in Asian Aquaculture*. New York: Springer.

Amlaku, A., J. Sölkner, R. Puskur, and M. Wurzinger (2012). "The Impact of Social Networks on Dairy Technology Adoption: Evidence from Northwest Ethiopia". *International Journal of AgriScience* 2(11): 1062-1083, available online: http://www.inacj.com/attachments/section/17/Temp%-20November%202012-650%20Amlaku%20Asres%20C%20P%20(1062-1083).pdf.

Asche, F., H. Hansen, and R. Tveteras (2009). " The Salmon Disease Crisis in Chile". *Marine Resources Economic* 24: 405-411, available online: http://ageconsearch.umn.edu/bitstream/94042/2/07-ASCHE%2024-4%201-11-10.pdf.

Aye K.M., K.K. Lay, H. Win, and S.S. De Silva (2007). "A New Freshwater Aquaculture Practice that has Successfully Targeted a Niche Export Market with Major Positive Societal Impacts: Myanmar". *Aquaculture Asia* XII(4): 22–26, available online: http://library.enaca.org/AquacultureAsia-/Articles/Oct-Dec-2007/aa-oct-dec-07-myanmar.pdf.

Bailey, C. (1988). "The Social Consequences of Tropical Shrimp Mariculture Development". *Ocean and Shoreline Management* 11: 31–44, available online: http://www.sciencedirect.com/science/article/pii/095183128890-0045.

Baker, J.L. (2000). *Evaluating the Impact of Development Projects on Poverty: A Handbook for Practitioners*. Washington, D.C.: The World Bank.

Bergquist, D. (2007). "Sustainability and Local People's Participation in Coastal Aquaculture: Regional Differences and Historical Experiences in Sri Lanka and the Philippines". *Environmental Management* 40: 787–802, available online: http://www.springerlink.com/content/062147-n502050g4u/.

Beveridge, M., M. Phillips, P. Dugan and R. Brummet (2010). "Barriers to Aquaculture Development as a Pathway to Poverty Alleviation and Food Security". In: OECD. Advancing the Aquaculture Agenda: Workshop Proceedings. Paris, pp. 345-359, available online: http://www.oecd.org/tad-/fisheries-/aquaculture.htm.

Bostock, J., B. McAndrew, R. Richards, K. Jauncey, T. Telfer, K. Lorenzen, D. Little, L. Ross, N. Handisyde, I. Gatward, and R. Corner (2010). "Aquaculture: Global Status and Trends". *Philosophical Transactions of the Royal Society* 365: 2897–2912, available online: http://rstb.-royalsocietypublishing.org/content/365-/1554/2897.short.

BPS KAKS (2011). Kepulauan Seribu dalam Angka 2011. Badan Pusat Statistik Kabupaten Kepulauan Seribu, Jakarta.

Cameron, A.C. and P.K. Trivedi (2010). *Microeconometrics Using Stata*. Texas: Stata Press.

CCMRS (2006). "*Konsep Pengembangan* Sea Farming *di Kabupaten Administrasi Kepulauan Seribu Provinsi DKI Jakarta*". Working Paper, Center of Coastal and Marine Resources Studies, Bogor Agricultural University, Bogor.

CCMRS (2007). "*Pengembangan Sea Farming di Kabupaten Administrasi Kepulauan Seribu*". Presentation, Center of Coastal and Marine Resources Studies, Bogor Agricultural University, Bogor.

CCMRS (2008). Laporan Akhir Sea Farming. Report, Center of Coastal and Marine Resources Studies, Bogor Agricultural University, Bogor.

Dey, M.M., M.L. Bose, and Md.F. Alam (2008). *Recommendation Domains for Pond Aquaculture Country Case Study: Development and Status of Freshwater Aquaculture in Bangladesh*. WorldFish Center Studies and Reviews No. 1872, The WorldFish Center, Penang, Malaysia, available online: http://aquaticcommons.org/1693/1/9789832346708.pdf.

De Silva, S.S. and F.B. Davy (2010). "Aquaculture Successes in Asia: Contributing to Sustained Development and Poverty Alleviation". In S.S. De Silva and F.B. Davy (Ed.). *Success Stories in Asian Aquaculture*. New York: Springer.

Dougherty, C. (2001). *Introduction to Econometrics*. New York: Oxford University Press.

Edwards, P. (2000). Aquaculture, Poverty Impacts, and Livelihoods. Working Paper No. 56, Overseas Development Institute, London, United Kingdom.

Effendi, I. (2006). "*Riset Terapan Pengembangan Sea Farming di Kepulauan Seribu*". Working Paper, Center of Coastal and Marine Resources Studies, Bogor Agricultural University, Bogor.

Esping-Andersen, G. (2000). "Social Indicators and Welfare Monitoring". Program Paper Number 2, United Nations Research Institute for Social Development, Geneva, available online: http://www.unrisd.org-/80256B3C005BCCF9/(httpPublications)/6D649FEB5030431980256B5E004DE81A?OpenDocument.

FAO (2009). *The State of World Fisheries and Aquaculture 2008*. Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Department, Rome, available online: http://www.fao.org/docrep/011-/i0250e-/i0250e00.htm.

FAO (2012). *The State of World Fisheries and Aquaculture 2012*. Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Department, Rome, available online: http://www.fao.org/docrep/016-/i2727e-/i2727e00.htm.

Feder, G., R.E. Just, and D. Zilberman (1985). "Adoption of Agricultural Innovations in Developing Countries: A Survey". *Economic Development and Cultural Change* 33(2): 255-298, available online: http://www.jstor.org/stable/1153228?seq=1.

Ghadim, A.K.A, D.J. Pannel, and M.P. Burton (2005). "Risk, Uncertainty, and Learning in Adoption of a Crop Innovation". *Agricultural Economics* 33: 1–9, available online: http://onlinelibrary.wiley.com/doi/10.1111/j.1574-0862.2005.00433.x/pdf.

Giddens, A (2009). *Sociology*. Cambridge: Polity Press.

Gujarati, D.N. and D.C. Porter (2009). *Basic Econometrics*. Singapore: McGraw-Hill Education (Asia).

Gurung, T.B., R.M. Mulmi, K.C. Kalyan, G. Wagle, G.B. Pradhan, K. Upadhayaya, and A.K. Rai (2010). "Cage Fish Culture: An Alternative Livelihood Option for Communities Displaced by Reservoir Impoundment in Kulekhani, Nepal". In S.S. De Silva and F.B. Davy (Ed.). *Success Stories in Asian Aquaculture*. New York: Springer.

Hagenaars, A. and K. de Vos (1988). "The Definition and Measurement of Poverty". *The Journal of Human Resources* 23(2): 211-221, available online: http://www.jstor.org/stable/145776?seq=1.

Halwart, M. (2005). "The Role of Aquaculture in Rural Development". *Agriculture and Rural Development* 2: 41-44, available online: http:-//rural21.medianet-kunden.de/uploads/media/ELR_aquaculture_and_rural_-development_0205.pdf.

Hariri, E. (2010). "*Evaluasi Kinerja Keuangan Usaha Budidaya Ikan Kerapu Macan pada Anggota Kelompok* Sea Farming *di Pulau Panggang*". Bachelor Thesis, Bogor Agricultural University, Bogor.

Haswanto, A.L. (2006). "*Studi Konstruksi Kelembagaan Pengelolaan Sea Farming: Kasus di Pulau Panggang Kabupaten Administrasi Kepulauan Seribu*". Master Thesis, IPB Graduate School, Bogor Agricultural University, Bogor.

Haughton, J. and S.R. Khandker (2009). *Handbook on Poverty and Inequality*. World Bank, Washington D.C.

Hiheglo, P.K. (2008). "Aquaculture in Ghana: Prospects, Challenges, Antidotes and Future Perspectives". Master Thesis, University of Tromsø, Norway.

Holloway, G., B. Shankar, and S. Rahman (2002). "Bayesian Spatial Probit Estimation: A Primer and an Application to HYV Rice Adoption". Agricultural Economics 27(3): 383-402, available online: http://www.sciencedirect.com/science/article/pii/S0169515002000701.

Irz, X., J.R. Stevenson, A. Tanoy, P. Villarante, and P. Morissens (2007). "The Equity and Poverty Impacts of Aquaculture: Insights from the Philippines". *Development Policy Review* 25(4): 495-516, available online: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-7679.2007.00382.x/pdf.

Jamu, D.M. and O.A. Ayinla (2003). "Potential for the Development of Aquaculture in Africa". *Naga of the WorldFish Center Quarterly* 26(3): 9-13, available online: http://worldfishcenter.org/Naga/Naga26-3/pdf/naga_26no3_feature2.pdf.

Kabunga, N.S. (2011). Improving the Welfare of Smallholder Farmers through Biotechnology: Analyzing Adoption and Impacts of Tissue Culture Bananas in Kenya. PhD Dissertation, Georg-August Universität Göttingen, Göttingen.

Kakwani, N. and J. Silber (2007). *The Many Dimensions of Poverty*. Basingstoke: Palgrave Macmillan.

Kaliba, A.R., C.C. Ngugi, J.M. Mackambo, K.O. Osewe, E. Senkondo, B.V. Mnembuka, and S. Amisah (2007). "Potential Effect of Aquaculture Promotion on Poverty Reduction in Sub-Saharan Africa". *Aquacult Int* 15: 445–459, available online: http://link.springer.com/article/10.1007/s10499-007-9110-5?null#page-1.

Kapanda, K.N., D.H. Ng'ong'ola, G.G.Matiya, H. Tchale, D. Jamu, and E.W.K. Kaunda (2003). "Factors affecting Adoption of Fish Farming in Malawi: A Case of Mchinji Rural Development Programme". *Aqua-Fish Tech. Rep.* 2: 34-38.

Kelurahan Pulau Panggang (2010). Laporan Tahunan 2009. Report, Pemerintah Kabupaten Administrasi Kepulauan Seribu, Provinsi Daerah Khusus Ibukota Jakarta, Jakarta.

KKP (2011). Kelautan dan Perikanan dalam Angka 2011. Kementerian Kelautan dan Perikanan Republik Indonesia, Jakarta, available online: statistik.kkp.go.id/index.php/arsip/file/37/kpda11_ok_r06_v02.pdf/.

Klasen, S. (2000). "Measuring Poverty and Deprivation in South Africa". *Review of Income and Wealth* 46(1): 33-58, available online: http://onlinelibrary.-wiley.com/doi/10.1111/j.1475-4991.2000.tb00390.x/pdf.

Lashgarara, F. and A. Saharkhiz (2012). "Factors Affecting the Participation of Fars Province's Aqua Culturists in Extension-Educational Courses". *World Applied Sciences Journal* 17 (1): 61-65, available online: http://idosi.org/wasj/wasj17(1)12/9.pdf.

Lea, S. (1997). *Topic 4: Logistic Regression and Discriminant Analysis*. University of Exeter, Exeter, available online: http://people.exeter.ac.uk-/SEGLea/multvar2/disclogi.html.

Lister, R. (2004). *Poverty*. Cambridge: Polity Press.

Lynch, L. and S.J. Lovell (2001). "Factors Influencing Participation in Agricultural Land Preservation Programs". Working Papers No. 01-05, Department of Agricultural and Resources Economics, The University of Maryland, College Park, Maryland, available online: http://ageconsearch.umn.edu/bitstream/28590/1/wp01-05.pdf.

Nagubadi, V., K.T. McNamara, W.L. Hoover, and W.L. Mills Jr. (1996). "Program Participation Behavior of Nonindustrial Forest Landowners: A Probit Analysis". *Journal of Agricultural and Applied Economics* 28(2): 323–336, available online: https://fp.auburn.edu/sfws/Nagubadi-/nagubadi_JAAE.PDF.

Naylor, R.L., R.J. Goldburg, H. Mooney, M. Beveridge, J. Clay, C. Folke, N. Kautsky, J. Lubchenco, J. Primavera, and M. Williams (1998). "Nature's Subsidies to Shrimp and Salmon Farming". *Science* 282(5390): 883–884, available online: http://www.sciencemag.org/content/282/5390/883.full.

OECD (2010). "Advancing the Aquaculture Agenda: Workshop Proceedings". Workshop Proceedings, Organisation for Economic Co-operation and Development, Paris, available online: http://www.oecd.org/tad/fisheries-/aquaculture.htm.

Ogundari, K. and S.O. Ojo (2009). "An Examination of Income Generation Potential of Aquaculture Farms in Alleviating Household Poverty: Estimation and Policy Implications from Nigeria". *Turkish Journal of Fisheries and Aquatic Sciences* 9: 39-45, available online: http://www.trjfas.org/pdf/issue_9_1-/39_45.pdf.

Phuong, N.T. and D.T.H. Oanh (2010). "Striped Catfish Aquaculture in Vietnam: A Decade of Unprecedented Development". In S.S. De Silva and F.B. Davy (Ed.). *Success Stories in Asian Aquaculture*. New York: Springer.

Pollock, L.J. (2005). "Integration of Aquaculture within Irrigation Systems: A Poverty-focused Approach". PhD Dissertation, University of Stirling, Stirling.

Pouomogne, V. and D.E. Pemsl (2008). *Recommendation Domains for Pond Aquaculture Country Case Study: Development and Status of Freshwater Aquaculture in Cameroon*. WorldFish Center Studies and Reviews No. 1871, The WorldFish Center, Penang, Malaysia, available online: http://aquaticcommons.org/1692/1/9789832346654.pdf.

Puspitasari, R. (2008). "*Analisis Ekonomi Budidaya Ikan Kerapu pada Kelompok* Sea Farming *dengan Sistem Keramba Jaring Apung dan Jaring Tancap di Kelurahan Pulang Panggang, Kepulauan Seribu*". Bachelor Thesis, Bogor Agricultural University, Bogor.

Rahayu, A.M. (2009). "*Keragaman dan Keberadaan Penyakit Bakterial dan Parasitik Benih Kerapu Macan* Epinephelus fuscoguttatus *di Keramba Jaring Apung Balai* Sea Farming *Kabupaten Administrasi Kepulauan Seribu, Jakarta*". Bachelor Thesis, Bogor Agricultural University, Bogor.

Rahm, M.R. and W.E. Huffman (1984). "The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables". *American Journal of Agricultural Economics* 66: 405-413, available online: ajae.oxfordjournals.org/content/66/4/405.full.pdf+html.

Rangkuti, A.S. (2008). "*Efektivitas dan Strategi Pengembangan* Sea Farming *di Kabupaten Kepulauan Seribu*". Bachelor Thesis, Bogor Agricultural University, Bogor.

Rio (2009). "*Pemberdayaan Komunitas Nelayan melalui Penerapan Program Sea Farming: Studi Kasus Komunitas Nelayan* Sea Farming *Pulau Panggang, Kelurahan Pulau Panggang, Kabupaten Administratif Kepulauan Seribu*". Bachelor Thesis, Bogor Agricultural University, Bogor.

Rogers, E.M. (2003). Diffusion of Innovations. New York: Simon & Schuster International.

Rudiyanto, B.P. (2011). "*Analisis Kelembagaan dan Biaya Transaksi dalam Pengelolaan* Sea Farming *di Pulau Panggang Kabupaten Administrasi Kepulauan Seribu*". Master Thesis, IPB Graduate School, Bogor Agricultural University, Bogor.

Russell, A.J.M., P.A. Grötz, S.K. Kriesemer, and D.E. Pemsl (2008). *Recommendation Domains for Pond Aquaculture Country Case Study: Development and Status of Freshwater Aquaculture in Malawi*. WorldFish Center Studies and Reviews No. 1869, The WorldFish Center, Penang,

Malaysia, available online: http://aquaticcommons.org/1691/1/9789832-346647.pdf.

Sen, A. (2001). *Development as Freedom*. New York: Oxford University Press.

Siebert, R., M. Toogood, and A. Knierim (2006). "Factors Affecting European Farmers' Participation in Biodiversity Policies". *Sociologia Ruralis* 46(4): 318-340, available online: http://onlinelibrary.wiley.com/doi/10.1111-/j.1467-9523.2006.00420.x/pdf.

Sindato, C., E.N. Kimbita, and S.N. Kibona (2008). "Factors Influencing Individual and Community Participation in the Control of Tsetse Flies and Human African Trypanosomiasis in Urambo District, Tanzania". *Tanzania Journal of Health Research* 10(1): 20-27, available online: http://www.ajol.info/index.php/thrb/article/viewFile/14337/2688.

Solihin, A., M.A. Al Amin, and D.I. Hartoto (2011). "*Praktik Pengelolaan Sumberdaya Perikanan Berbasis Kearifan Lokal*". In L. Adrianto (Ed.). Konstruksi Lokal Pengelolaan Sumberdaya Perikanan di Indonesia. Bogor: IPB Press.

Stickney, R.R. (2000). *Encyclopedia of Aquaculture*. New York: John Wiley and Sons, Inc.

Stone, K., MM. Bhat, R. Bhatta, and A. Mathews (2008). "Factors Influencing Community Participation in Mangroves Restoration: A Contingent Valuation Analysis". *Ocean and Coastal Management* 51(6): 476-484, available online: http://www.sciencedirect.com/science/article/pii-/S0964569108000276.

Tacon, A.G.J., M. Metian, G.M. Turchini and S.S. De Silva (2009). "Responsible Aquaculture and Trophic Level Implications to Global Fish Supply". *Reviews in Fisheries Science* 18(1): 94-105, available online: http://dx.doi.org/10.1080-/10641260903325680.

Thilsted, S.H., N. Roos and N. Hassan (1997). "The Role of Small Indigenous Fish Species in Food and Nutrition Security in Bangladesh". *Naga Supplement of the ICLARM Quarterly* 20(3/4): 82-84, available online: http://www.worldfishcenter.org/Naga/na_2273.pdf.

Thorbecke, E. (2007). "Multi-dimensional Poverty: Conceptual and Measurement Issues". In N. Kakwani and J. Silber (Ed.). *The Many Dimensions of Poverty*. Basingstoke: Palgrave Macmillan.

Townsend, P. (1979). *Poverty in the United Kingdom*. Harmondsworth, Middlesex: Penguin Books.

Trobos (2012). Outlook Perikanan 2012: Industrialisasi Perikanan Budidaya. Available online: http://www.trobos.com/show_article.php?rid=12&aid-=3227.

Umesh, N.R., A.B.C. Mohan, G. Ravibabu, P.A. Padiyar, M.J. Phillips,C.V. Mohan and B.V. Bhat (2010). "Shrimp Farmers in India: Empowering Small-Scale Farmers through a Cluster-Based Approach". In S.S. De Silva and F.B. Davy (Ed.). *Success Stories in Asian Aquaculture*. New York: Springer.

van Mulekom, L., A. Axelsson, E.P. Batungbacal, D. Baxter, R. Siregar, I. de la Torre, SEAFish for Justice (2006). "Trade and Export Orientation of fisheries in Southeast Asia: Under-Priced Export at the Expense of Domestic Food Security and Local Economies". *Ocean and Coastal Management* 49: 546-561, available online: http://www.sciencedirect.com-/science/article/pii/S0964569106000779.

Wahyuni, S. (2008). "*Analisis Skala Ekonomi Budidaya Kerapu dalam Kerangka* Sea Farming *di Kelurahan Pulau Panggang, Kabupaten Administratif Kepulauan Seribu*". Bachelor Thesis, Bogor Agricultural University, Bogor.

Weimin, M. (2010). "Recent Developments in Rice-Fish Culture in China: A Holistic Approach for Livelihood Improvement in Rural Areas". In S.S. De Silva and F.B. Davy (Ed.). *Success Stories in Asian Aquaculture*. New York: Springer.

World Bank (2000). *World Development Report 2000/2001: Attacking Poverty*. World Bank, New York: Oxford University Press, available online: http://elibrary.worldbank.org/.

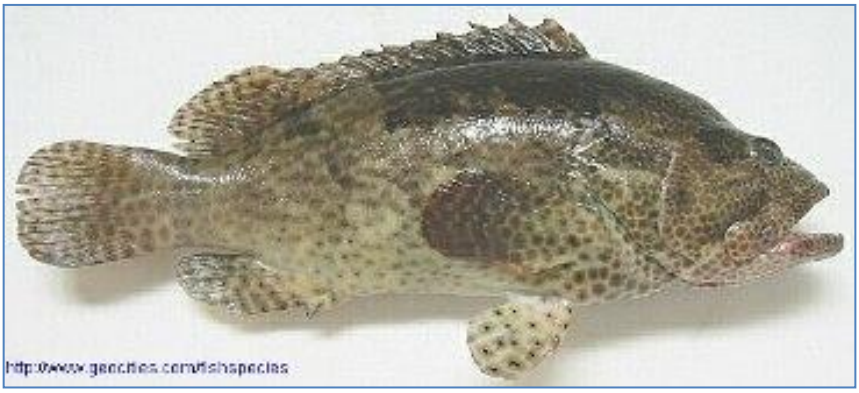
WorldFish Center (2011). "Aquaculture, Fisheries, Poverty, and Food Security". Working Paper 2011-65, The WorldFish Center, Penang, Malaysia, available online: http://www.worldfishcenter.org/resource_centre-/WF_2971.pdf.

Yapa, L.S. and R.C. Mayfield (1978). "Non-adoption of Innovations: Evidence from Discriminant Analysis". *Economic Geography* 54: 145-156, available online: http://www.jstor.org/stable/10.2307/142849.

Zbinden, S. and D.R. Lee (2005). "Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program". *World Development* 33(2): 255-272, available online: http://intranet.catie.ac.cr-/intranet/posgrado/politica_gober/2011/GOBERNANZA%20INTRANET%20MODULO%20III/seminario%203/Lecturas%20Seminario%203/12%20Paying%20for%20environmental%20services.pdf.

Appendices

Appendix 1. Picture of Brown Marbled Grouper and Humpback Grouper



(a) Brown-marbled Grouper (www.geocities.com, 2013)

(b) Humpback Grouper (www.fishingkaki.com, 2013)

Appendix 2. Picture of Cage Culture and Pen Culture in Panggang Island

(a) Cage Culture (Author, 2013)

(b) Cage from Local Government (Author, 2013)

(c) Pen Culture (Author, 2013)

Appendix 3. Stata Output for the Determinants of Sea Farming Participation

a. Probit Regression

```
. probit sfp age educt fishermen hhsz org_member maxp  bt05  mp05

Iteration 0:   log likelihood = -52.845155
Iteration 1:   log likelihood = -21.233962
Iteration 2:   log likelihood = -19.962676
Iteration 3:   log likelihood = -19.930594
Iteration 4:   log likelihood = -19.930497
Iteration 5:   log likelihood = -19.930497

Probit regression                                 Number of obs   =         77
                                                  LR chi2(8)      =      65.83
                                                  Prob > chi2     =     0.0000
Log likelihood = -19.930497                       Pseudo R2       =     0.6229

------------------------------------------------------------------------------
         sfp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .0106146   .0359464     0.30   0.768    -.0598391    .0810682
       educt |  -1.910569   .8590528    -2.22   0.026    -3.594282   -.2268566
  fishermen |  -2.040857   .8978012    -2.27   0.023    -3.800515   -.2811988
        hhsz |  -.5897702   .2381756    -2.48   0.013    -1.056586   -.1229547
  org_member |  -3.710483   .8522799    -4.35   0.000    -5.380921   -2.040045
        maxp |   .3513968   .1148345     3.06   0.002     .1263254    .5764683
        bt05 |   .8233153   .5212119     1.58   0.114    -.1982413    1.844872
        mp05 |   .9794679   .5196448     1.88   0.059    -.0390173    1.997953
       _cons |   2.943545   1.535773     1.92   0.055    -.0665158    5.953605
------------------------------------------------------------------------------
```

b. Marginal Effects

```
. mfx

Marginal effects after probit
      y  = Pr(sfp) (predict)
         =  .38685918

------------------------------------------------------------------------------
variable |      dy/dx   Std. Err.      z    P>|z|  [    95% C.I.   ]       X
---------+--------------------------------------------------------------------
     age |   .0040631     .01373     0.30   0.767   -.02285   .030976   37.8182
   educt*|  -.4670796     .12461    -3.75   0.000   -.711302 -.222858    .14285
fisher~n*|  -.6568812     .15817    -4.15   0.000   -.966889 -.346873    .83117
    hhsz |  -.2257577     .09151    -2.47   0.014   -.405121 -.046395    4.6364
org_me~r*|  -.7921949     .09145    -8.66   0.000   -.971424 -.612966    .29870
    maxp |   .1345109     .04392     3.06   0.002    .048436  .220585    4.2208
    bt05 |   .3151562     .20805     1.51   0.130   -.092615  .722928    .42857
    mp05 |   .3749297     .20028     1.87   0.061   -.017607  .767466    .35065
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

Appendix 4. Stata Output for Sea Farming Impacts on Household Income

a. OLS Regression

```
. regress totinc sfp fishermen org_member maxp mp10
```

Source	SS	df	MS	Number of obs =	76
Model	8.7260e+15	5	1.7452e+15	F(5, 70) =	10.98
Residual	1.1123e+16	70	1.5891e+14	Prob > F =	0.0000
				R-squared =	0.4396
				Adj R-squared =	0.3996
Total	1.9850e+16	75	2.6466e+14	Root MSE =	1.3e+07

totinc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
sfp	4901929	3938522	1.24	0.217	-2953206	1.28e+07
fishermen	-1.96e+07	4092013	-4.78	0.000	-2.77e+07	-1.14e+07
org_member	7451221	4148003	1.80	0.077	-821710.8	1.57e+07
maxp	1033860	560720.5	1.84	0.069	-84462.16	2152181
mp10	3239393	1229792	2.63	0.010	786649.1	5692136
_cons	3.44e+07	5454915	6.31	0.000	2.35e+07	4.53e+07

b. Two-sample t-test with Unequal Variances

```
. ttest totinc, by( participant) unequal

Two-sample t test with unequal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	43	2.87e+07	2297679	1.51e+07	2.41e+07	3.34e+07
1	34	3.52e+07	2924901	1.71e+07	2.92e+07	4.11e+07
combined	77	3.16e+07	1845087	1.62e+07	2.79e+07	3.52e+07
diff		-6446330	3719459		-1.39e+07	978930.3

```
    diff = mean(0) - mean(1)                                      t =  -1.7331
Ho: diff = 0                     Satterthwaite's degrees of freedom =  66.4215

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0439         Pr(|T| > |t|) = 0.0877          Pr(T > t) = 0.9561
```

Glossary

Aquaculture
The production of aquatic plants and animals under controlled or semi-controlled conditions for direct or indirect human consumption.

Absolute poverty
It is lacking sufficient money to meet basic physical needs.

Cage culture
Rearing of aquatic organisms in enclosures generally constructed of wire or netting as bags supported rigid frames which are floated or suspended in large bodies of water.

Capability
Denotes what a person can do or be, that is, the range of choices that are open to her.

Capture fisheries
Refers to all the catch done in the natural habitat of the fish such as seas, lakes and in freshwater.

Early adopter
Individual whose time-of-adoption is greater than one standard deviation earlier than the average time-of-adoption.

Ecosystem approach to aquaculture
a strategy for the integration of the activity within the wider ecosystem in such a way that it promotes sustainable development, equity and resilience of interlinked social and ecological systems.

Extensive culture
Naturally occuring microflora and microfauna supply all nutritional requirements.

Fingerling
A very young fish.

Fisheries co-management
A partnership arrangement in which the government, community, and other stakeholders share the responsibility and authority for marine and coastal fisheries management.

Functioning
Refers to what a person actually manages to do or be; they range from elementary nourishment to more sophisticated levels such as participation in the life of the community and the achievement of self-respect.

Grouper
Groupers are fish of any of a number of genera in the subfamily *Epinephelinae* of the family *Serranidae*, in the order *Perciformes*. They live throughout most warm and temperate marine regions, serranids are highly valued for food, and both small and large species are kept in aquariums. They habitually eat fish, octopuses, and crustaceans.

Household
One or more persons, whether related or unrelated, who share common living quarters.

Minapolitan
Clustering system which integrate marine and fisheries economic activities into one area consisting center of production, processing, marketing/trade, and also housing (particularly for fishermen, aquaculturists, and traders).

Poverty
It is pronounced deprivation in well-being.

Pen culture
Fixed enclosure in which the bottom is the bed of the water body.

Rearing
It is an activity for raising fish to expected size.

Relative poverty
It is lacking of the resources required to obtain the types of diet, participate in activities, and enjoy living standards that are customary or widely accepted in the society where they belong.

Risk mitigation
It consists of certain activities that reduce the frequency or severity of losses.

Salmonid
It is belong to or characteristic of the family Salmonidae, which includes the salmon, trout, and white fish.

Semi-intensive culture
Ponds are intentionally fertilized with nutrients (e.g. manure, phosphates) to stimulate natural food production, or when supplement feed is added.

Social exclusion
The outcome of multiple deprivations which prevent individuals or groups from participating fully in the economic, social, and political life of the society in which they are located.

Social network
A network of social interactions and personal relationships.

Social quality
The extent to which citizens (and other residents) are able to participate in the social and economic life of their communities under conditions which enhance their well-being and individual potential.

Vulnerability
An assessment of the magnitude of the threat of poverty, measured *ex-ante*, before uncertainty is resolved.

Well-being
The state of being comfortable, healthy, or happy.

Statutory Declaration

I herewith declare that I composed my thesis submitted independently without having used any other sources or means than stated therein.

Date: 18 January 2013 Signature: Evita Fathia Luthfina