MODEL FOR DEVELOPING HOME INDUSTRY TIGER GROUPER HATCHERY FIRMS (HSRT) IN BALI: An Overview on Economic and Maricultural Perspective

By

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ABSTRACT

The high demand to grouper seeds in domestic and international market had pushed the mass grouper seeds production in Gerokgak District, Bali. At the first research, there were gaps between the average actual hatchery productivity of Tiger grouper (*Epinephelus fuscoguttatus*) hatchery firms with the potentially achievable productivity. This research then aimed for improving the productivity by determination of economic efficiency and optimum inputs combination. The research utilized data which were collected with survey to 41 samples of hatchery firms in Gerokgak District.

The result in dry season: the average technical efficiency was 0.88903; the price efficiency was 1,554; and the economic efficiency was 1,381. In wet season the average technical efficiency was 0,72055; the price efficiency was 6,469, and the economic efficiency 4,661. The optimum inputs combination in dry season was grouper eggs 750 thousands pieces; pellet 6,0 kg; artemia 40 cans; mysid shrimp 660 sacks; *rotifer* 61 sacks; and workers 5 men. In wet season was grouper eggs 500 thousands pieces; pellet 6,0 kg; artemia 21 cans; mysid shrimp 210 sacks; *rotifer* 46 sacks; and workers 3 men. These optimum inputs could make meaningful contributions toward rising productivity and profitability of the Tiger grouper hatchery firms. Besides that, close attention should be given to improving managerial ability of the farmers and to preparing adroit hatchery workers through education and training.

Keywords: coastal communities, grouper, hatchery, technical efficiency, economic efficiency

INTRODUCTION

Coastal and sea resources could be trade on national economic improvements. Various potential resources continuously explorated and developed, included in coastal cultivation, with potential product, groupers. Groupers cultivation should be developed due to its excellent economic value, and besides that it could lessen coral reef destructions (Hanafi et al., 2002). Groupers cultivation in Indonesia included hatchery (producing seeds/juveniles), and raising fishes in basket net in sea (producing groupers for consumtion). Each of the two producing stages could be a stand alone business.

The high demand to fresh Tiger groupers (*Epinephelus fuscoguttatus*) in international market (Hongkong, Singapore, Japan and China) had pushed dramatically the development of the home industry Tiger grouper hatchery firms in Bali, where its centre for productions located all along the coastal area in Gerokgak District, Buleleng Regency (about 1.200 grouper hatchery firms had been operating in this area). The successfulness of mass seeds/juveniles production here had extended positive impacts of increasing: non fuel export, labors absorption, incomes for coastal communities, and prevention to criminal action of environment damages in coastal area. In the Year 2007 the total product of Tiger grouper juveniles in Bali was 9.387.200 pieces (6.954.500 pieces were sold in domestic trading, and 2.432.700 pieces were exported). The total value of these juveniles trading was 11.264,64 millions *rupiahs* (The Fishes Quarantine Office-Ngurah Rai Denpasar, 2008).

The research of Kardi (2007) clarified that the average juveniles production of 31 samples home industry Tiger grouper hatchery firms in dry season was 33.780 pieces per cyclus production (the time period from disseminating grouper eggs till juveniles harvest was ±50 days), with average grouper eggs dissemination of 420 thousands pieces or the *sintasan* level was 9,86% and coefficient of variance was 48,6% (high variously). Its average profit was Rp 6.150.000,- per cyclus production. According to the research of Giri et al. (2006) at fishery experiment station in Gerokgak, the average *sintasan* of Tiger grouper juveniles in dry season was 15,50%, and in wet season was 12,25% with average profit Rp 9.350.000,- per cyclus. The productivity of the home industry Tiger grouper hatchery firms in Gerokgak District were very variously and enough lower than the productivity at experiment station, as well as their profitability. This yield gap could be caused by some factors. According to Widodo (1989) higher production level is dependently on: behaviour and ability of farmers, inputs level applicated, socioeconomic factors (managerial ability, education, and farmer's off-hatchery job) and climate (dry or wet season). Identification the role of these factors was expected to give some advantages in the efforts to enhance technical efficiency, price efficiency and economic efficiency of Tiger grouper hatchery firms and to develope the firms. Therefore, this research was conducted with aims: (1) to analyze the technical efficiency among the Tiger grouper hatchery farmers; (2) to analyze the economic efficiency of the Tiger grouper hatchery firms; (3) to analyze cost and return (R/C) of the Tiger grouper hatchery firms; (4) to analyze socioeconomic factors influence the juveniles production of the hatchery firms; and (5) to obtain the optimum inputs combination for Tiger grouper hatchery firms. Each analysis was done for production in dry and wet season.

RESEARCH METHODS

Theoretical framework of input efficiency

The comprehension of efficiency in producing is that efficiency is ratio output per input refers to achieve maximum output within a set of inputs, that the higher output ratio means the higher efficiency. Efficiency is the best usage inputs in producing product (Shone, Rinald in Susantun, 2000). Farrel (1957) distinguished efficiency into three, those: (1) technical efficiency, (2) alocative or Price efficiency, and (3) economic efficiency. Technical efficiency deals with input-output relationship. It is output per unit of input where inputs are aggregated in some manner. According to: Richmont (1974), Aigner et al. (1977) Battese and Corra (1977) and Collie (1955) in Zen et al. (2002), *Frontier* production function represents usage of technology extensively by companies in an industri. Model of *frontier* production function is proposed for measurement of technical efficiency in a company. The model can be written as:

$$Y = f(X_i, \beta) \exp \varepsilon_i \qquad (1)$$

Where β is a set of estimated parameter. X_i is input, and $\varepsilon_i = v_i + u_i$. The error is supposed negative and increasing due to intersection of normal distribution with average nol dan positive variance σ_u^2. This describe technical efficiency of a company. On the other word *error* v_i assumed has normal distribution with average nol dan variance positive σ_u^2, that describing error of measurement interrelated with uncontrolled factors in relation with production.

Technical efficiency can be measured using parameter of ratio that given by γ as follow (Battese and Corra (1997) in Zen et al. (2002)):

$$\gamma = (\sigma_u^2) / (\sigma^2) \quad (2)$$

Where $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $0 \le \gamma \le 1$ (3)

Jondrow et al. (1982) in Zen et al. (2002) and Squires et al. (2003) noted condition of average u_i and ε_i as:

$$E(u_i | \varepsilon_i) = (\sigma_u \sigma_v / \sigma).\{[f(\varepsilon_i \lambda \sigma^{-1}) / (1 - F(\varepsilon_i \lambda \sigma^{-1}))] - (\varepsilon_i \lambda \sigma^{-1})\} \quad (4)$$

Where ε_i is a sum of v_i and u_i, $\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$, λ is a ratio σ_u/σ_v, each f and F is standard normal density and distribution function that evaluated at $\varepsilon_i \lambda \sigma^{-1}$. The measurement of technical efficiency for each companies can be calculated with $TE_i = \exp[E(u_i | \varepsilon_i)]$, and so $0 \le TE_i \le 1$.

According to Nicholson (1995) price efficiency is achieved when the ratio marginal value productivity per input price (NPM_{Xi}/P_{Xi}) or $k_i = 1$. This condition requires NPM_X equal with price of production factor X or it can be written as

$$bYP_y / X = P_X \quad (5)$$

or $bYP_y / X P_X = 1$, (6)

where P_X = price of production factor X.

Economic efficiency (EE) denotes a product of technical efficiency (TE) and price efficiency (PE) (Susantun, 2000). Hence economic efficiency can be achieved when both efficiencies are achieved, so it can be written as

$$EE = TE.PE \quad (7)$$

Data and analytical methods

This study utilized data from the intensive study conducted in 7 villages of grouper seeds/juveniles producing area in Gerokgak District, Bali. The main data collection were conducted with survey to 41 samples of hatchery firms in the 7 villages. On each of 41 Tiger grouper hatchery firms was measured: quantities of fixed inputs and variable inputs and production; inputs and production price; and socioeconomic factors (farmer's managerial ability, education, and farmer's off-hatchery job).

Cobb-Douglas production function was choosed as functional relationship between Tiger grouper juveniles production and its variable inputs. The log normal form of its production function was as

$$Ln\,Y = \alpha + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + \beta_6 LnX_6 \quad (8)$$

Estimation of this production function used *Maximum Likelihood Estimation* (MLE) method in *Software Frontier 4.1.*

Concerning socioeconomic factors (farmer's managerial ability, education, and farmer's off-hatchery job), the effect of these factors on juveniles production of Tiger grouper hatchery firms was analyzed with model Cobb-Douglas production function as:

$$\text{Ln } Y = \alpha + \beta_1 \text{Ln } X_1 + \beta_2 \text{Ln } X_2 + \beta_3 \text{Ln } X_3 + \beta_4 \text{Ln } X_4 + \beta_5 \text{Ln } X_5 + \beta_6 \text{Ln } X_6 + \beta_7 \text{Ln } X_7 + \beta_8 \text{Ln } X_8 + \beta_9 \text{Ln } e^{X9} \quad (9)$$

Estimation of this function used *Ordinary Least Square* (*OLS*) method in *Software SPSS 15*

Table 1. Definition of operational variables for juveniles production function

Variable	Code	Definition	Measurement scale
Production	LnY	Logarithm of juveniles production per cyclus	pieces
Grouper egg	Ln X_1	Logarithm of Grouper eggs per cyclus	Thousand pieces
Pellet feed	Ln X_2	Logarithm of pellet feed per cyclus	kg
Artemia	Ln X_3	Logarithm of artemia per cyclus	can
Mysid shrimp	Ln X_4	Logarithm of mysid shrimp per cyclus	sack
Rotifer	Ln X_5	Logarithm of *rotifer* per cyclus	sack
Worker	Ln X_6	Logarithm of workers per cyclus	men
Education	Ln X_7	Logarithm of formal education	ordinal
Managerial ability	Ln X_8	Logarithm of technical efficiency	-
Farmer's off-hatchery job	X_9	Farmer with or without off-hatcery job	Nominal (With =1; Without = 0)

RESULTS AND DISCUSSION

The technical efficiency of grouper juveniles production

The average grouper juveniles production of 41 samples Tiger grouper hatchery firms in dry season was 59.791 pieces/cyclus production. They disseminated grouper eggs with average 571951 pieces, so these grouper hatchery firms only could produce juveniles with average survival rate or *sintasan* 10,74% (lower than average *sintasan* at experiment station 15,5%). The result of frontier production function analysis on the grouper juveniles production in dry season (Table 2) indicated that factors pellet feed (X_2), mysid shrimp (X_4), *rotifer* (X_5), and workers (X_6) were significant. Among these factors, *rotifer* (X_5) with negative regression coefficient indicated negative effect on juveniles production do to excessively utilization. Too more supply of *rotifer*s impeded *Nannochloropsis oculatas* reproduction. *Nannochloropsis oculatas* were significant *fitoplanktons* as initial natural feed for well growing of grouper larvas . Therefore, the stunted *Nannochloropsis oculata* reproduction by excessively utilization of *rotifer*s decreased the juveniles production. Here the hatchery farmers should controle the utilization of *rotifer*s. On the contrary the factors pellet feed (X_2), mysid shrimp (X_4), and workers (X_6) with positive regression coefficients indicated that utilization of these factors could be increased to make more viable larvas to be juveniles (increasing *sintasan*).

Table 2. The result of estimating frontier production function on the Tiger grouper juveniles production in dry season

Variable	Coeficient	t-ratio	Significance
Constant	8,31638	4.7887	0,00003*
LnX_1 (Grouper egg)	0,25216	1.4201	0,16442ns
LnX_2 (Pellet feed)	0,20063	2.5464	0,01544*
LnX_3 (Artemia)	0,03609	0.2790	0,78189ns
LnX_4 (Mysid shrimp)	0,18473	2.0166	0,05000*
LnX_5 (*Rotifer*)	-0,62503	-3.1258	0,00355*
LnX_6 (Workers)	0,37674	3.5169	0,00123*
Log likelihood	33,65936		
Average technical efficiency (TE)	0.88903		
Average technical inefficiency (1-TE)	0.11097		
Return to scale (RTS)	0,42532		

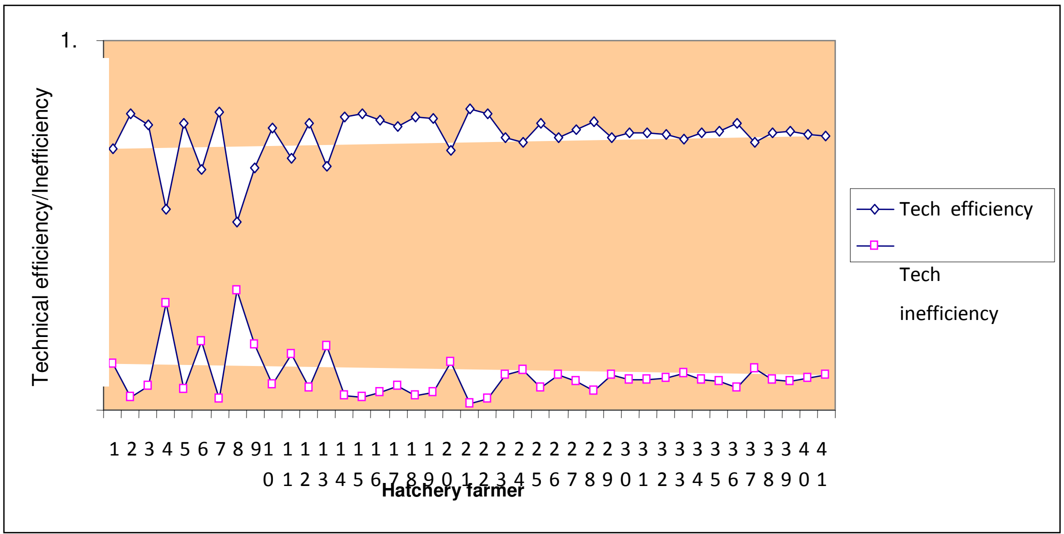
Informations: * = significant; ns = non significant

The description for technical efficiency and technical inefficiency of 41 samples Tiger grouper hatchery firms in dry season (Figure 1) depicted that the managerial ability among the hatchery farmers in acclimating technology to produce grouper juveniles was enough variously. The average technical efficiency (TE) of the grouper hatchery firms was 0,88903 (Table 2), with average actual production (QY)

59.791 pieces/farmer, but its average potential production (QQ) was 67.174 pieces/farmer. This case indicated that the actual juveniles production was lower than potential juveniles production, so it was very required some efforts to increase juveniles production.

The average technical efficiency = 0,88903 was lower than 1 (one) yet, indicated that the technical efficiency among the Tiger hatchery farmers in dry season was not efficient, so it was possible to add the quantity of some inputs which allocated to increase juveniles production. The average technical inefficiency (1-TE) = 0,11097 indicated some failures to use hatchery equipments and to allocate some variable inputs in achieving maximum juveniles production.

Figure 1. The technical efficiency and technical inefficiency of 41 samples Tiger grouper hatchery firms in dry season



The average juveniles production of the grouper hatchery firms in wet season was 56.558 pieces/cyclus production. They disseminated grouper eggs with average 560.975 pieces, so these they only could produce grouper juveniles with average *sintasan* 10,42% (lower than average *sintasan* at experiment station 12,25%). The result of frontier production function analysis on the grouper juveniles production in wet season (Table 3) indicated that factors artemia (X_3), mysid shrimp (X_4), *rotifer* (X_5), and workers (X_6) were significant. Among these factors, mysid shrimp (X_4) with negative regression coefficient indicated negative effect on the juveniles production do to excessively utilization. Too more feed of mysid shrimps made defected digestion in grouper seeds. It was caused by complication in digesting shell of mysid shrimps, accumulation of these shells in digestion increased the mortality of the seeds. Here the hatchery farmers should controle the utilization of mysid shrimps. On the contrary, the factors artemia (X_3), *rotifer* (X_5) and workers (X_6) with positive regression coefficients indicated that utilization of these factors could be increased to make increasing *sintasan*.

The description for technical efficiency and technical inefficiency of 41 samples Tiger grouper hatchery firms in wet season (Figure 2) depicted that the managerial ability among the grouper hatchery farmers in acclimating technology to produce grouper juveniles in wet season was very variously and more variously than the managerial ability in dry season. The average technical efficiency (TE) of these 41 Tiger grouper hatchery firms was 0,72055, with average actual production (QY) 56.558 pieces/farmer, but its average potential production (QQ) was 78.390 pieces/farmer. This case indicated that the actual juveniles production was lower than potential juveniles production, so it was very required some efforts to increase juveniles production.

Table 3. The result of estimating frontier production function for the Tiger grouper juveniles production in wet season

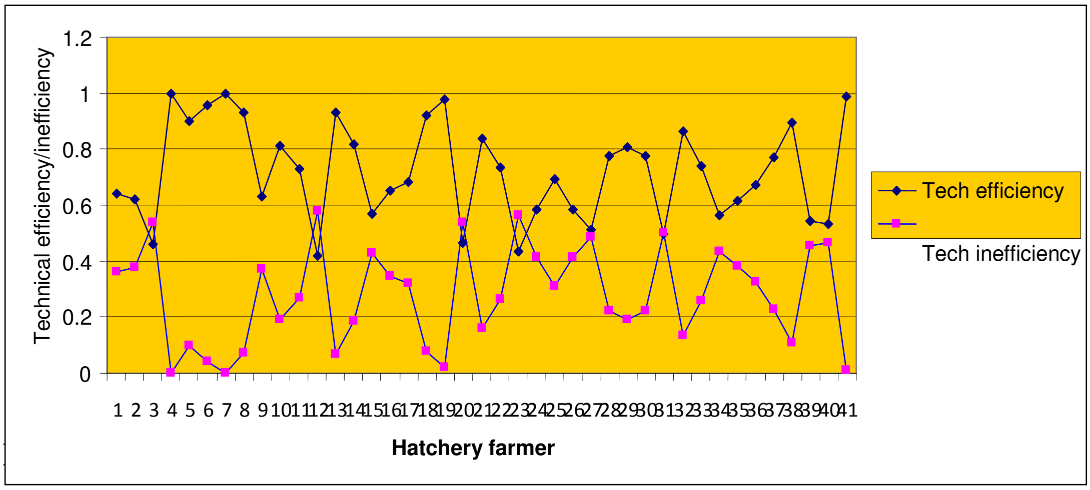
Variable	Coeficient	t-ratio	Significance
Constant	9.08944	10,2262	0,00000*
LnX_1 (Grouper egg)	0.15507	1,3768	0,17732^{ns}
LnX_2 (Pellet feed)	0.16365	0,3556	0,72427^{ns}
LnX_3 (Artemia)	0.31655	1,7654	0,08622*
LnX_4 (Mysid shrimp)	-0.65045	-2,2068	0,03398*
LnX_5 (*Rotifer*)	0.51251	2,3534	0,02435*
LnX_6 (Workers)	0.57042	6,1489	0,00000*
Log likelihood	4,36202		
Average technical efficiency (TE)	0,72055		
Average technical inefficiency (1-TE)	0,27945		

Return to scale (RTS)	1,06775

Informations: * = significant; ns = non significant

The average technical efficiency (TE) = 0,72055 indicated that the technical efficiency of the Tiger hatchery firms in wet season was inefficient, so it was possible to add the quantity of some inputs which allocated to increase juveniles production. The average technical inefficiency (1-TE) = 0,27945 indicated some failures to use hatchery equipments and to allocate some variable inputs in achieving maximum juveniles production. This inefficiency was more seriously than inefficiency of production in dry season.

Figure 2. The technical efficiency and technical inefficiency of 41 sample Tiger grouper hatchery firms in wet season



The result of allocative efficiency analysis for the grouper juveniles production in dry season (Table 4) indicated that the ratio marginal value productivity per input price for several inputs: grouper egg, pellet feed, mysid shrimp, and workers were lack of efficient (> 1), but inputs: artemia, and *rotifer* were not efficient (< 1). The average allocative efficiency of these 6 inputs (PE) was 1,554, and so the economic efficiency (EE = TE x PE) was 1,381 (not efficient). Therefore, to improve the total efficiency or to achieve economic efficient (production and profit closely to maximum level) for the home industry Tiger grouper hatchery firms in dry season, the allocation of the inputs: grouper egg, pellet feed, mysid shrimp, and workers should be increased, but allocation of the inputs: artemia, and *rotifer* should be decreased.

Table 4. The price/allocative efficiency and economic efficiency of the Tiger grouper hatchery firms in dry season

Variabel	Regression Coeficient	Ratio NPM_x / P_x	Efficiency		
LnX_1 (Grouper egg)	0,25216	19,58213	PE	=	1,554
LnX_2 (Pellet feed)	0,20063	11,62090	TE	=	0,889
LnX_3 (Artemia)	0,03609	0,33313	EE	=	1,381
LnX_4 (Mysid shrimp)	0,18473	3,57054			
LnX_5 (*Rotifer*)	-0,62503	-28,85790			
LnX_6 (Workers)	0,37674	3,07536			

The result of allocative efficiency analysis for grouper juveniles production in wet season (Table 5) indicated that the ratio marginal value productivity per input price for several inputs: grouper egg, pellet feed, artemia, *rotifer* and workers were lack of efficient (> 1), but input mysid shrimp was not efficient (< 1). The average allocative efficiency of these 6 inputs (PE) was 6,469, and so the economic efficiency (EE = TE x PE) was 4,661 (not efficient). Therefore, to improve the total efficiency or to achieve economic efficient in wet season, the allocation: grouper egg, pellet feed, *rotifer* and workers should be increased, but the allocation of the input mysid shrimp should be decreased.

Table 5. Price/allocative efficiency and economic efficiency of Tiger grouper hatchery firms in wet season

Variabel	Regression Coeficient	Ratio NPM_x / P_x	Efficiency		
LnX_1 (Grouper egg)	0,15507	11,61410	EH	=	6,469
LnX_2 (Pellet feed)	0,16365	8,53220	ET	=	0,720
LnX_3 (Artemia)	0,31655	2,84428	EE	=	4,661
LnX_4 (Mysid shrimp)	-0,65045	-12,24290			
LnX_5 (*Rotifer*)	0,51251	23,66714			
LnX_6 (Workers)	0,57042	4,40462			

The cost and return of the Tiger grouper hatchery firms

The average return of 41 samples Tiger grouper hatchery firms in dry season was Rp 77.728.585,-. Its average cost was Rp 42.011.476,-, so the average profit of the firms was Rp 35.717.110,-/cyclus production, with standard deviation Rp 12.273.513,-/cyclus production or the coefficient of variance was 34,36% (not so much variously). The whole process of Tiger grouper hatchery firm for one cyclus production (from preparation for hatchery means and equipments till crop and packaging) needed time 4 (four) months, so the average profit per month was Rp 8.929.000,-.

The average return in wet season was Rp 73.525.780,-. Its average cost was Rp 41.230.784,-, so the average profit of the firms was Rp 32.294.996,-/cyclus production, with standard deviation Rp 17.804.839,-/cyclus production or the coefficient of variance was 55,13% (enough variously), so the average profit per month was Rp 8.073.750,-.

The effect of socioeconomic factors on the grouper juveniles production

The effect of the factor managerial ability of the hatchery farmers was very significant on the grouper juveniles production in dry season, but the factors formal education and farmer's off-hatchery job were not significant. Eventhough some hatchery farmers had low education (SD or SMP) and they had off-hatchery jobs, but these two cases not caused the juveniles production in low quantity due to not bad their managerial ability. The managerial ability was very dominant to determine the successfulness to produce juveniles in high productivity, which was indicated by its coefficient elasticity 1,265 (>1). Management for hatchery firm denoted as the ability of a farmer to determine, to organize and to coordinate inputs application as efficient as possible. The measurement for the success of this firm management was productivity per input or productivity of the firm. The gist of this matter, a hatchery farmer was not only as a worker but also as manager to order organization of producing juveniles in totality manner.

The effect of factors managerial ability and formal eduction were very significant on the grouper juveniles production in wet season, but the factor farmer's off-hatchery job were not significant. The running of hatchery firm in wet season was rather more intricated than the running in dry season, due to the declining quality of the coastal watter (purity, plankton riches, sterility from *pathogen*) during the wet season. So the capability to analyze of the farmers with higher formal education influenced the higher juveniles production.

Optimum inputs combination for Tiger grouper hatchery firm

From all appearances the grouper hatchery practices were different only among farmers not among hatchery locations or hatchery techniques. Therefore, the point of optimum inputs combination here was projected from the graph of the sum technical efficiency plus profit hatchery firm (per Rp 100.000.000,-) possessed by each of 41 hatchery farmers. The result were presented in the Appendices.

The highest sum of technical efficiency plus profit hatchery firm for the juveniles production in dry season was 1,596 which achieved by the hatchery farmer number 15. The empirical data of the farmer number 15 that he applicated inputs combination of $\underline{X}_D = (X_1;\ X_2;\ X_3;\ X_4;\ X_5;\ X_6) = (750.000;\ 6;\ 40;\ 660;\ 61;\ 5)$, and so the optimum inputs combination for the Tiger grouper hatchery firm in dry season were: grouper eggs = 750 thousands pieces; pellet feed = 6 kg; artemia = 40 cans; mysid shrimp = 660 sacks; *rotifer* = 61 sacks; and workers = 5 men.

In the same manner the highest value in wet season was 1,714 which achieved by the farmer number 13. This farmer applicated inputs combination of $\underline{X}_W$ = (X_1; X_2; X_3; X_4; X_5; X_6) = (500.000; 6; 21; 210; 46; 3), and so the optimum inputs combination in wet season were: grouper eggs = 500 thousands pieces; pellet feed = 6 kg; artemia = 21 cans; mysid shrimp = 210 sacks; *rotifer* = 46 sacks; and workers = 3 men.

Implication

The analysis of marinecultural production especially for grouper hatchery production had become an important step in the formulation of marinecultural policy. It was an internal part of the development policy making because of the strategic position of grouper hatcheries to push the development of raising groupers companies and to alleviate the poor of the coastal communities. The policy objective was often to identify the possibilities for increasing output, while conserving some resource uses, particularly under development policy which emphasizes sustainable marine resources and cultivation with secure fishes product.

Concerning the developing home industry Tiger grouper hatchery firms, the excessively allocation of inputs artemia and *rotifer* in the Tiger grouper hatchery firms in dry season should be changed to increase the allocation of the inputs pellet feed, mysid shrimp, and workers, while for the excessively allocation of the input mysid shrimp in wet season should be changed to increase the allocation of the inputs pellet feed, artemia, and workers. The hatchery farmers whose production capacity of disseminating Tiger grouper eggs about 750 thousands pieces in dry season should allocate pellet feed = 6,0 kg, artemia = 40 cans, mysid shrimp = 660 sacks, *rotifer* = 61 sacks, and worker = 5 men. The hatchery farmers who had production capacity of disseminating Tiger grouper eggs about 500 thousands pieces in wet season should allocate pellet feed = 6,0 kg, artemia = 21 cans, mysid shrimp = 210 sacks, *rotifer* = 46 sacks, and workers = 3 men. The local governments in cooperating with finance institutions or banks should prepare soft loan to new hatchery doers whose human capital to run hatchery firm was sufficient. As well as to prepare adroit back-yard hatchery workers through education and training to the local human resources in coastal communities in Bali.

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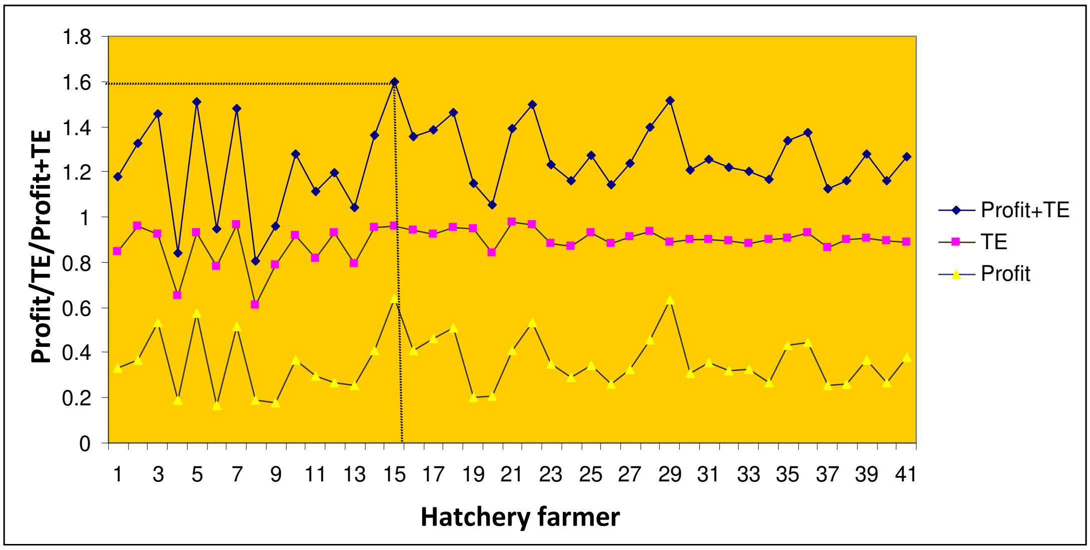
Appendices

The Graphs for technical efficiency; profit ; and sum of technical efficiency plus profit of the juveniles production in dry season



The Graphs for technical efficiency; profit ; and sum of technical efficiency plus profit of the juveniles production in wet season