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**ECONOMICS OF AQUACULTURE, SEA-FISHING
AND COASTAL RESOURCE USE IN ASIA**

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ECONOMICS OF TAMBAK CULTURE (BRACKISH WATER FISH CULTURE) IN THE NORTH COAST OF JAVA^{1/}

Toto Sugito^{2/}

Introduction

The Food Balance Sheet of Indonesia 1968-1974 shows that per capita consumption of protein, especially animal protein is below minimum requirement. Milkfish culture appears to be an appropriate measure for animal protein production in the country.

Together with the Philippines and Taiwan, Indonesia is one of the major producers of milkfish in the world. It accounts for nearly 50% of the total area under milkfish culture in South East Asia. In Indonesia itself, Tambak culture occupies about 65% of the total area of fish ponds.

This paper was based on the results of the Tambak culture Census, a part of the Agricultural Census conducted at the end of 1973. The analysis was confined to Java, which contributed 63% of the total area under Tambak culture in Indonesia. Tambak culture is mostly done in the north coast of Java. The census selected at random 6,026 sample ponds out of the more than 18,000 holding in Java. Whatever the result, it should be kept in mind that the census data was generally underestimated.

Economic Structure

Average size of Tambak holding and production distribution: The average size of Tambak holding in Java, was 2.60 ha. with East Java having the largest, 3.44 ha. compared with 2.63 ha. in West Java and 1.84 ha. in Central Java.

The size of individual Tambak holding varied from less than 1 ha to over 15 has. About 57% were less than 2 has, accounting for 20% of the total area and 26% of the total production (Figure 1). On the contrary, 12.4% of Tambak holders had 5 has. or more. These large farms occupied 44.8% of the total area and accounted for 36.4% of the total production.

Number of persons engaged in Tambak culture: There were about 1.7 persons working in a farm of whom 1.4 were household members and about 0.3 was hired worker. Such a proportion between household members and hired worker did not change much until the farm size became 10 has. Further, the number of hired workers per holding did not increase substantially with the increase in farm size (Table 1). This means that Tambak operation is primarily done by household members regardless of farm size.

^{1/} This paper is based on the project of the Team Agricultural Census Analysis, CBS, Jakarta in close cooperation with the Directorate General of Fisheries and assisted by Dr. T. Yamamoto.

^{2/} Central Bureau of Statistics

Table 1. Average number of persons engaged in tambak culture per household by province.

| Size of farm (ha.) | DKI Jakarta | | | West Java | | | Central Java | | | East Java | | |
|-----------------------|-------------|--------------------------|-----------------|-----------|--------------------------|-----------------|--------------|--------------------------|-----------------|-----------|--------------------------|-----------------|
| | Total | House- hold member | Hired worker | Total | House- hold member | Hired worker | Total | House- hold member | Hired worker | Total | House- hold member | Hired worker |
| Total | 2.1 | 1.4 | 0.7 | 1.6 | 1.3 | 0.3 | 1.7 | 1.6 | 0.1 | 1.7 | 1.4 | 0.3 |
| Less than 1 | 1.9 | 1.2 | 0.7 | 1.4 | 1.3 | 0.1 | 1.5 | 1.5 | 0.0 | 1.3 | 1.1 | 0.2 |
| 1-2 | 1.8 | 1.4 | 0.4 | 1.5 | 1.4 | 0.1 | 1.7 | 1.6 | 0.1 | 1.6 | 1.4 | 0.2 |
| 2-3 | 3.0 | 1.7 | 1.3 | 1.4 | 1.2 | 0.2 | 1.8 | 1.6 | 0.2 | 1.7 | 1.4 | 0.3 |
| 3-4 | 2.2 | 2.0 | 0.2 | 2.0 | 1.6 | 0.4 | 2.0 | 0.2 | 1.7 | 1.8 | 1.4 | 0.3 |
| 4-5 | 3.3 | 2.0 | 1.3 | 1.6 | 1.2 | 0.4 | 2.2 | 1.9 | 0.3 | 1.9 | 1.6 | 0.3 |
| 5-10 | 2.2 | 2.8 | 0.4 | 2.2 | 1.4 | 0.8 | 2.7 | 2.1 | 0.6 | 1.9 | 1.4 | 0.5 |
| 10-15 | 2.6 | 2.6 | - | 2.9 | 1.2 | 1.7 | 2.5 | 2.1 | 0.4 | 2.5 | 1.4 | 1.1 |
| More than 15 | 3.9 | 1.3 | 2.6 | 4.6 | 1.7 | 2.3 | 4.8 | 2.4 | 2.4 | 3.9 | 1.4 | 2.5 |

Productivity and species composition. Productivity per ha. varied from 180 kg. in West Java to 540 kg. in D.K.I. Jakarta. This could probably be due to limitations in labor input. Figure 2 shows that in general, the larger the size of management, the lower the productivity per ha. On the contrary, the larger the size of management, the more area is worked by one person.

Percentage production of milkfish, shrimp and others were 64.0, 19.1 and 16.9%, respectively.

Type of management: Majority of Tambak holding were single proprietorships (93%), Partnership and cooperatives being 6.9% and 0.1%, respectively.

By tenure status, 78.7 of the ponds were owned — 75.6% individually and 3.1% jointly owned. The rest were either rented from the Government or other people.

Although a farm may have several compartments, most of them (78%) were located within the same location. The rest, 18.1% and 3.8%, had 2 and 3 or more compartments, respectively.

Stocking rate and survival rate

Stocking. Although stocking of milkfish in ponds was widely practiced, natural stocking was relied upon by 4% in Central Java to 31.6% in D.K.I. Jakarta. Polyculture of milkfish and shrimp was seldom done (Table 2).

Milkfish culture, in principle, followed two major steps, i.e. (a) nursing fry into fingerling and (b) rearing fingerling into marketable size. Stocking was mostly done in the form of fry, rather than fingerling, except in Jakarta and to some extent in West Java (Table 3).

Table 2. Distribution of Tambak holding by species and province.

| Province | Total | Milkfish | | Stocked | | | Natural stocking | |
|----------------|-------|-----------|----------------|---------|--------|---------------|------------------|------|
| | | Sub-Total | Milk Fish Only | Shrimp | Others | Shrimp Others | | |
| D.K.I. Jakarta | 100.0 | 59.8 | 58.9 | — | 1.0 | — | 8.6 | 31.8 |
| West Java | 100.0 | 69.8 | 67.1 | — | 2.5 | — | 8.4 | 22.0 |
| Central Java | 100.0 | 95.4 | 92.6 | 1.7 | 1.1 | — | 0.6 | 4.0 |
| East Java | 100.0 | 81.2 | 29.2 | — | 1.5 | 0.5 | 1.5 | 16. |

The rates of stocking per hectare recommended by a World Bank Tambak Culture consultant in Indonesia were as follows:

Fry : 2,000 to 5,000 pieces per ha.

Fingerling : 1,000 to 2,000 pieces per ha.

Actual practice followed more or less the above standards with an average of 3,322 pieces for the whole Java.

Survival rate during the course of rearing was very low, being 24%. However, such survival rate was slightly better in D.K.I. Jakarta and Central Java, where intensive culture had been developed to some extent (Table 4).

Technical nature of Tambak culture

Ponds were being used (81%) both rearing and salt making (13%), both rearing and nursing (5.6%) and for nursing only (0.5%)

For all provinces about 90% of the ponds had muddy bottom and the rest (10%) was sandy. Natural irrigation throughout the year was available for more than 80% of the pond area except East Java. Moreover, in East Java and DKI Jakarta most ponds had brackish water.

Although the use of pesticide and fertilizer was practiced to some extent they were not used by 87% of the ponds.

Table 3. Distribution of tambak holdings by type of stock by province

| Province | Total | Stocked | | | Natural Stocking |
|----------------|-------|-----------|------|------------|------------------|
| | | Sub-total | Fry | Fingerling | |
| D.K.I. Jakarta | 100.0 | 59.8 | 33.3 | 50.8 | 40.2 |
| West Java | 100.0 | 69.6 | 58.6 | 21.7 | 30.4 |
| Central Java | 100.0 | 95.4 | 94.0 | 8.0 | 4.6 |
| East Java | 100.0 | 81.2 | 79.0 | 8.2 | 18.8 |

Table 4. Production of milkfish and survival rate by province.

| Province | Total No. of fry and fingerling stock (10^6) | Quantity Produced | | Survival rate (%) |
|----------------|--|-------------------|-------------------|-------------------|
| | | Tons | Number (10^3) | |
| Java Island | 161.8 | 764.7 | 38,235 | 23.6 |
| D.K.I. Jakarta | 2.2 | 13.1 | 655 | 29.8 |
| West Java | 21.8 | 66.3 | 3,315 | 15.2 |
| Central Java | 54.8 | 3,121 | 15,605 | 28.5 |
| East Java | 83.0 | 3,732 | 18,660 | 22.5 |

Loan and investment

Loan The loan data presented here referred to 1973. Hence the *small holder credit scheme* which was introduced sometimes in 1975 under the cooperative programme between BRI and the Directorate General of Fishery and the *IDA credit scheme* that started in June 1975 was excluded. It can be stated that the present credit situation for Tambak culture is more improved than what is presented in this paper.

Out of the 18,677 Tambak holdings in Java, only 5,082 or 25% were able to borrow loans. Out of these, 27% were awarded public loan and 73% with private loan. The main source of private loan was the fish dealers.

The total amount loaned from private sources in 1973 for the whole Java was 209 million rupiah (US\$ 290 thousand). In one year the cooperative awarded only 0.598 million rupiah (US\$ 1,441). It seemed that the cooperative played a very insignificant role. The average loan per holding per year amounted to 41,074 rupiah (US\$ 99).

Investment: The Tambak Census surveyed the size of investment of classifying it broadly into that for pond itself and that for pond accessories. A summary account of overall investment in Java was as follows:

| | 000S | % |
|-------------------------------------|------|-------|
| Total amount of Investment (I + II) | 705 | 100.0 |
| I Pond itself | 328 | 46.5 |
| Renovation of pond | 252 | 35.7 |
| Construction of new pond | 76 | 10.8 |
| II Pond accessories | 377 | 53.5 |
| Cottage | 81 | 11.6 |
| Sluice | 238 | 33.7 |
| Boat | 18 | 2.5 |
| Fishing Net | 36 | 5.1 |
| Water Pump | 4 | 0.6 |

Judging from these small figures it seemed that renovation of pond was mainly a maintenance rather than an improvement of the pond structure, while pond construction was done in partly finished form. Cottages, sluices and boats were simple.

Cost and Earnings

For the comparative analysis of the cost and earning of Tambak culture, the 1973 Tambak Census in Indonesia as well as the studies on "Intensive Milk Fish Culture" conducted by the Shrimp Culture Research Center in Jepara from 1973 to 1975^{3/} was used. For comparison, data from the Philippines came from the Department of Agriculture and Natural Resources, National Food and Agricultural Council, 1973 and data for Taiwan came from a survey of the Taiwan Fisheries Bureau in 1973.^{4/}

Data from the 1973 Tambak Census in Java referred to one year prior to November 1973, whereas data for Taiwan and the Philippines referred to calendar year 1972 although these surveys were carried out in 1973. Data for Java were based on 6,026 randomly selected sample. Data for Taiwan were based on 177 Tambak holdings, which were also randomly selected, whereas, data for the Philippines were based on 93 milkfish producers. The latter survey was probably biased in favor of the more efficient operators.

As these surveys were independently designed, there were some differences in the classification of cost items and concept of income. To make a proper comparison of data among the three countries, the analysis, therefore, used the following concepts and procedures:

^{3/} Reference was made to a paper entitled "Year round multiple cropping to increase production of milkfish, *Chanos chanos*, from shallow brackish water pond" by P.G. Padlan et al, Bull. Shrimp Cult. Res. 1(2).

^{4/} These data were quoted from a paper entitled "Economic Comparison of Milkfish Farming in Taiwan and the Philippines, 1972-1975" written by Yung C. Shang, Hawaii Institute of Marine Biology, University of Hawaii.

- a) No depreciation was taken into account.
- b) Gross income was defined as follows:

Gross Income I Wages of hired laborers and the imputed cost of household labor were deducted from the total sale together with other costs (Table 5).

Gross Income II Only the wage of hired laborers was deducted from the total sale together with other costs (Table 5) The labor cost of household members which was normally imputed was part of their income. Thus, in assessing the actual income of Tambak households this gross income was more realistic.

In the present analysis the costs of rent, tax and interest are not treated as operational costs, although these cost are covered in the Taiwan and Philippines data. Again, the way of assessing these costs was not always internationally standardized. Further, these costs were not included in the 1973 Indonesia Census. Since these costs were not deducted from total sale, together with other costs, both gross incomes I and II had been slightly over-estimate

In Shang's paper, Taiwan and Philippines data were given in US\$. Therefore, the data for Indonesia were converted into \$ by applying an official exchange rate of Rp. 415 per US\$. Further, to make the three sets of data, the size of management was converted in terms of per hectare

Some weakness of data used

Data given in Table 5 had some weaknesses, summarized as follows:

- a) "Total sale" which was obtained by an interview like the Tambak census was generally a bit under-estimated. This had made, to a certain extent, the size of gross income smaller.
- b) In estimating the number of milkfish harvested, survival rate assumed an average weight of 200 grams per fish. This had made the accuracy of survival rate less, since there must be some differences among the provinces.
- c) Labor cost of Indonesia did not include the labor cost of household members engaged in Tambak culture. Since this cost was included in Taiwan and Philippines data, the wage of household members was imputed by the following formula:

Rp. 200 X 10 X 12 X average no. of household member

Rp. 200 = daily wage, 10 = days, and 12 = months per ha.

Analysis of cost and earnings of Tambak culture hereunder was made excluding DKI Jakarta, since area of Tambak culture in DKI Jakarta was very small as compared to the area of whole Java. Furthermore, the area was diminishing due to urbanization.

The majority of Tambak holdings were owner operated. For assessing the income of Tambak household, therefore, it would be more realistic to use "gross income II" as defined above. Analysis was, therefore made ignoring the labor cost of household members, although Table 5 gives figures related to both gross income I and II.

Productivity of Tambak culture in Java was low. Low productivity of Tambak culture naturally made the total sale low. Thus, the average total sale per ha. throughout Java was only \$89, although that of Central Java exceeded \$100.

Total operational cost per ha. in Java was only \$37.1. It is significant to note that in any Province, around one half of the operational cost came from the cost of fish seed, followed by hired labor. The actual cost per ha. for pesticide, fertilizer and feed did not exceed \$1.5. As discussed earlier the majority of Tambak holdings did not use these

Table 5. Comparative cost and earning of tambak culture per ha in Indonesia.

| Area Surveyed | c/ Throughout Java | | | | |
|--|--------------------|---------|-----------|--------------|-----------|
| | Unit | DI Aceh | West Java | Central Java | East Java |
| Milk fish stocking rate (A) | number | 8,212 | 3,322 | 2,593 | 3,646 |
| Total production | kg | 671 | 245 | 176 | 354 |
| Milk fish production (B) | kg | 509 | 157 | 79 | 208 |
| Milk fish (B) = (B) / 200 gr | number | 2,544 | 785 | 395 | 1,038 |
| Survival rate (B) / (A) | % | 31.0 | 23.6 | 15.2 | 28.5 |
| Total sale (C) | \$ | 359.0 | 89.4 | 72.3 | 115.4 |
| Total operational cost I ^{a/} | \$ | 274.2 | 69.4 | 69.4 | 99.3 |
| Total operational cost II b/ | \$ | 164.3 | 37.1 | 40.5 | 48.9 |
| Labor cost/ 1 Household member | \$ | 109.9 | 32.3 | 28.9 | 50.4 |
| 2: Employed laborer | \$ | 37.1 | 11.1 | 15.9 | 11.6 |
| Fish seed | \$ | 84.8 | 17.4 | 15.4 | 25.0 |
| Pesticide | \$ | 7.2 | 0.7 | 0.0 | 1.0 |
| Feed | \$ | 4.1 | 0.5 | 1.0 | 0.0 |
| Fertilizer | \$ | 3.6 | 0.2 | 0.0 | 0.7 |
| Maintenance | \$ | 19.1 | 4.8 | 6.0 | 7.2 |
| Others | \$ | 8.4 | 2.4 | 2.2 | 3.4 |
| Gross Income I (E) = (C) (D) | \$ | 84.8 | 20.0 | 2.9 | 16.1 |
| Gross Income II (E) = (C) (D) | \$ | 194.7 | 52.3 | 31.8 | 66.5 |
| Profitability I (E) / (C) | % | 23.6 | 22.4 | 4.0 | 14.0 |
| Profitability II (E) / (C) | % | 54.2 | 58.5 | 44.0 | 57.6 |

a/ Includes labor cost of household member

b/ Excludes labor cost of household member

c/ Data for Aceh, which is also from the Census, is given for comparison.

materials. This, might be, the reason why survival rate was low, being only 23.6%.

The size of gross income II was also very low being only \$52.3. The gross income II per ha in Central Java was the highest, being \$66.5. This was probably due to the higher stocking rate per ha.

Profitability which was percentage of gross income II against the total sale was 58.5% in Java. This means that slightly more than 50% of the total sale will be the income of Tambak holder, although in a strict sense a certain amount of depreciation cost must be deducted from this.

Inter-country comparison

In this section, inter-country comparison of cost and earnings was made among Taiwan, the Philippines and Indonesia based on the materials listed earlier. These data including those obtained from an intensive milkfish culture experiment in Jepara were summarized in table 6.

Taiwan and Philippines data did not classify labor cost into that for household member and for hired labor. What was analyzed here was the gross income which was realized when Tambak culture was regarded as an enterprise i.e. "gross income I". Therefore, gross income discussed hereunder could not be compared with those analyzed in the previous section.

Table 6 may well suggest at least the following facts. Higher stocking rate of fish seeds, as practiced in Taiwan, and where feeds and fertilizers are often used will result to higher survival rate and hence high production per ha. The outcome of the intensified milkfish culture experiment in Jepara supported the fact that such a possibility existed even in Indonesia, although the level achieved did not reach that in Taiwan. It is noteworthy that the survival rate achieved in Jepara was equivalent to that in Taiwan. The total production per ha. in Taiwan was 2,067 kg, which was 8.4 times that in Java. Correspondingly, the total sales per ha. in Taiwan was also high, being 16.2 times as much as that in Java. Both the total production and the total sales per ha. in the Philippines were also better than those in Java due to higher stocking rate and use of feed and fertilizer, though not comparable with those in Taiwan.

The cost of fish seeds in Taiwan accounted for 45.4% of the total operational cost, compared with 14.7% in the Philippines and 25% in Java. The reason for this high percentage of fish seed cost in Taiwan was due to an extremely high price of fish seed compared with those in other countries. Since the unit price for the same commodity was quite different between countries, intercountry comparison of cost components in terms of percentage was not reasonable.

The only thing that could be clearly said with respect to cost component was that the cost of feed and fertilizer in Taiwan was extraordinarily high compared with that in the Philippines and Java. The actual cost of feed and fertilizer spent in Jepara experiment was comparable with that in Taiwan. This could be one of the reasons why Jepara experiment was able to achieve an excellent yield.

Corresponding to a very high production and hence a high sale, the size of "gross income I" in Taiwan was also high, being US\$ 340 per ha. Thus, "gross income I" in Taiwan was 17 times as much as that in Java.

The cost of pesticide was lacking in Taiwan and Philippines data. However, when cost components of Jepara experimental data were reviewed, the cost of pesticide was only \$23.4 per ha. per year, as compared with \$319.8 for feed and fertilizer.

Table 6. Comparative study on cost and earning of tambak culture in Taiwan, Philippines and Indonesia.

| Area Surveyed | Unit | Taiwan 1972 | Philippines 1972 | Indonesia 1973 | | |
|------------------------------------|------|----------------|---------------------|-----------------|---------|---------------------|
| | | | | Java as a whole | Jepara | c/ |
| Milk fish stocking rate (A) | no | 10,477 | 6,424 | 3,322 | | 7,295 |
| Total production | kg | 2,067 | 694 | 245 | | 1,172 |
| Milk fish production (B) | kg | | | 157 | | 1,004 |
| Milk fish production in number (B) | no | 8,381 | 3,469 | 785 | | 5,796 |
| Survival rate (B) / (A) | % | 80.0 | 54.0 | 23.6 | | 79.5 ^{a/} |
| Total sale (C) | \$ | 1,343.0 | 291.0 | 89.4 | | 725.8 ^{a/} |
| Total operational cost (B) | \$ | 1,003 | 156 | 69.4 | (100.0) | 521.0 |
| Labour cost ^{b/} | \$ | 187 | 71 | 43.4 | (45.6) | 57.8 |
| Fish seed | \$ | 456 | 23 | 17.4 | (14.7) | 96.6 |
| Pesticide | \$ | | | 0.7 | (1.0) | 23.4 |
| Feed and fertilizer | \$ | 283 | 28 | 0.7 | (1.0) | 319.8 |
| Maintenance | \$ | 46 | 3 | 4.8 | (6.9) | 19.3 |
| Others | \$ | 31 | 3 | 2.4 | (3.5) | 4.1 |
| Gross Income I (E) = (C)-(D) | \$ | 340 | 135 | 20.0 | | 204.8 |
| Profitability I (E) / (C) | % | 25.3 | 46.4 | 22.4 | | 28.2 |

^{a/} Estimated assuming that average price per kg. is Rp. 300 (\$0.72)

^{b/} Including labour cost from Family member

^{c/} Subjected to be revised in consultation with Shrimp Culture Research Center

Conclusion

Tambak culture in Java was characterized by low power input, low investment, low use of fertilizer, feed and pesticides. As a result the survival rate was small and hence the productivity was low. Consequently, the gross income was low. Judging from this, it seemed that most of the Tambak culture needed an extensive culture.

The average size of a pond was within the range of the size of pond generally recognized. Most pond bottom were muddy rather than sandy. Moreover, most of the ponds could fully enjoy natural irrigation throughout the whole year. Thus, it could be generally stated that technical nature of existing ponds more or less fit the conditions required.

D.K.I. Jakarta and also Aceh, which used more input in culturing, obtained higher productivity. The milkfish center in Jepara which used higher fry stocking rate and more feed and fertilizer, had a survival rate as high as Taiwan and hence high productivity. This means that the possibility of intensive culture exists in Java.

Judging from the situation of Tambak holders in Java, regardless of the size of management, they were in need of government assistance. To increase the income of Tambak holders and to increase the production of fish, the process of mass intensive culture in Java should be hastened.