

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT
CLASSI-
FICATION

A. PRIMARY

Food production and nutrition

AM00-0000-G662

B. SECONDARY

Fisheries--Indonesia

2. TITLE AND SUBTITLE

Brackish water aquaculture development in Northern Sumatra, Indonesia

3. AUTHOR(S)

Cremer, M. C.; Duncan, B. L.

4. DOCUMENT DATE

1978

5. NUMBER OF PAGES

38p.

6. ARC NUMBER

ARC ID639.32.C915

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Auburn

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

(Report for the period Nov.1, 1976 - Sept. 1, 1978)

9. ABSTRACT

10. CONTROL NUMBER

PN-AA6-560

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Aquaculture
Fisheries
Ponds
Milkfish

Shrimps
Indonesia

13. PROJECT NUMBER

497018900

14. CONTRACT NUMBER

AID/asia-C-1177

15. TYPE OF DOCUMENT

ID
639.32
C915

PN- AAG- 560
24

**BRACKISH WATER AQUACULTURE DEVELOPMENT
IN NORTHERN SUMATRA, INDONESIA**

by

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Project: Contract AID/Aiss-C-1177

**For the period:
November 1, 1976-September 1, 1978**

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BRACKISH WATER AQUACULTURE DEVELOPMENT IN

NORTHERN SUMATRA, INDONESIA

1 November 1976-1 September 1978

Michael C. Cremer and Bryan L. Duncan¹

INTRODUCTION

The Government of Indonesia received technical assistance in brackishwater aquaculture development from November 1976 to September 1978 through a contract between the U.S. Agency for International Development and Auburn University's International Center for Aquaculture. Contract AID/Asia-C-1177 provided funds for resident advisors and equipment to the Directorate General of Fisheries (DGF) for fish culture development and extension in northern Sumatra. The authors served in Medan, North Sumatra (Dr. Bryan L. Duncan)², and Banda Aceh, Aceh (Mr. Michael C. Cremer), from 1 November 1976 to 1 September 1978, as advisors to the Brackishwater Fishery Production Project (BFP).

Brackishwater pond culture has been practiced traditionally for centuries in Indonesia, particularly in Java. It was initiated at least 600 years ago as a mangrove swamp fishery using traps. Gradually, the mangrove was removed, dikes were constructed, water control structures were installed, and finally, the custom was established of stocking the ponds with milkfish and shrimp juveniles caught at sea.

In 1974, the DGF estimated that there were approximately 180,000 ha of brackishwater ponds in Indonesia, located mainly along the north coasts of Java,

¹Respectively, Research Associate and Assistant Professor, Department of Fisheries and Allied Aquacultures and International Center for Aquaculture, Auburn University.

²Dr. Bryan Duncan will remain in Indonesia for phase two of the project, an extension of the North Sumatra subproject until 30 October 1979 while Michael Cremer returned to Auburn University in September 1978.

South Sulawesi, and Sumatra. Production in these ponds had reached a plateau with the use of traditional technology, and new and more productive technology was not being adopted. During the Pelita I development program (1969-1974), the Government of Indonesia concentrated efforts to improve brackishwater pond fisheries through:

1) Adoption of new brackishwater methodology to Indonesia, using the vehicle of a UNDP/FAO project at Jepara, Central Java, as a base of operations for field trials and

2) Building of a staff base, through the use of local universities and secondary schools, for extending improved technology to existing and potential brackishwater fish farmers.

In 1974, as an expansion of the brackishwater development effort for Pelita II, the DGF chose Aceh and North Sumatra Provinces to be the first in a series of project sites where packages of resources would be brought to bear in a concerted effort to increase small farmer income and brackishwater fisheries production. The DGF requested AID to appraise the idea, and in November 1974, Dr. H. R. Schmittou³

conducted a survey of this area. He identified a high potential for aquaculture as a means to increase income, increase food production, and expand employment. In May, June, and July 1975, a project development team from the International Center for Aquaculture, USAID, and the Government of Indonesia visited the area and drafted a detailed project paper.⁴ In July 1976, Auburn University's International Center for Aquaculture received a 2-year contract from AID to assist the

³ Drs. Moss, McCoy, Grover and Prof. Snow of the International Center for Aquaculture, Auburn University, served as technical consultants on the project development team.

Government of Indonesia to increase brackishwater (tambak) fisheries production in seven kabupatens (districts) in the provinces of Aceh and North Sumatra and to create an infrastructure base upon which tambak expansion could take place.

Nine objectives were specified for the project:

1. Fry resources evaluated and improved capture and distribution programs operational.
2. Fertilizer utilization by fish farmers increased.
3. Lending by GOI Bank Rakyat for fish pond production and development increased.
4. Provincial programs (demonstrations, training, and extension) operational with technical assistance.
5. Trained staff functioning with technology and methodology for intensification outreach program.
6. Annual production from 4800 ha of existing tambaks doubled, from approximately 500 kg/ha/yr to 1000 kg/ha/yr.
7. New employment created for agricultural and fishery families.
8. Increased number and greater development roles for local producer associations.
9. GOI infrastructure in place and functional to handle remaining intensification and projected extensification.

This report outlines progress toward achieving these objectives during the initial two year project.

FRY RESOURCE EVALUATION

Fry supplies to support the brackish water pond industry in Indonesia come from naturally occurring stocks in coastal and estuarine waters. Expansion and improvement of the local fry capture and distribution sectors were identified as requirements for intensifying production and expanding pond area in northern Sumatra. As part of the BFP project milkfish and shrimp fry resources were evaluated for abundance and seasonal availability in the coastal waters of North Sumatra and Aceh, with the goals of increasing the volume of fry catch sufficient to double production and of improving handling and distribution methods so that 20% more of the captured fry reached the terminal market.

In North Sumatra Province, surveys in 1974-1976 by fishery biologists from the Bogor Institute of Aquaculture, the Inland Fisheries Research Institute, and the North Sumatra Fisheries Service showed milkfish fry were not present in significant numbers. Surveys by BFP project personnel in 1976-1978 confirmed a lack of milkfish fry in the North Sumatra area. Evaluation of shrimp post larvae resources, however, indicated abundant shrimp fry along the coast. Shrimp surveys were conducted periodically throughout the project, with field surveys combined with training programs for fishermen to teach gear construction, capture techniques, and handling and selection of post larvae. Approximately 1,115 man-days of effort were utilized in the fry survey. Results thus far indicate that the white shrimps, Penaeus indicus and P. merguensis, are the most abundant species of economic importance, while the highly valued tiger prawn, P. monodon, occurs in considerably lower numbers.

In Aceh Province, milkfish fry surveys conducted in 1977 and 1978 identified fry capture grounds, seasonal availability of fry, number of fry captured, total fry needs of Aceh, and number of people employed in the fry capture industry.

Fry collection grounds covering 296 kilometers of coastline were identified in kabupatens Aceh Besar, Pidie, Aceh Utara, and Aceh Timur. Additional fry grounds were identified surrounding several islands off the north coast of Aceh. These islands, Palu Weh, Palau Aceh, and Pulau Nasi, represent largely untapped sources for milkfish fry. A survey along the west coast of Aceh (Aceh Barat) also identified potential collection areas. It is doubtful, however, that fry resources in Aceh Barat can be utilized in the near future because of difficulties in transporting fry to fish farming areas.

Survey data indicate milkfish fry are present along the Aceh coast from March to December. Peak abundance occurs during the periods April to June and October to November.

An estimated 121 million milkfish fry were captured in Aceh coastal waters during 1977. Approximately 72 million fry are required annually by fish farmers in Aceh for stocking coastal tambaks. The remaining 49 million fry are available for sale to fish farmers outside of Aceh.

Milkfish fry collecting provided employment for an estimated 3,424 people during 1978. Fry collectors included housewives, artisanal fishermen, tambak laborers, students, rice farmers, and unemployed persons.

A shrimp fry survey was conducted in Aceh by BFP project staff in 1977. Shrimp fry and juveniles were found in coastal waters of four Kabupatens. Species identified were Penaeus indicus, P. merguensis, P. monodon, P. monoceros, P. semisulcatus, and Metapenaeus sp. Species available in greatest number were P. indicus and P. merguensis, both of which are cultured for local and export markets by Aceh fish farmers. P. monodon is also commercially cultured, but represents less than 10% of shrimp production from tambaks.

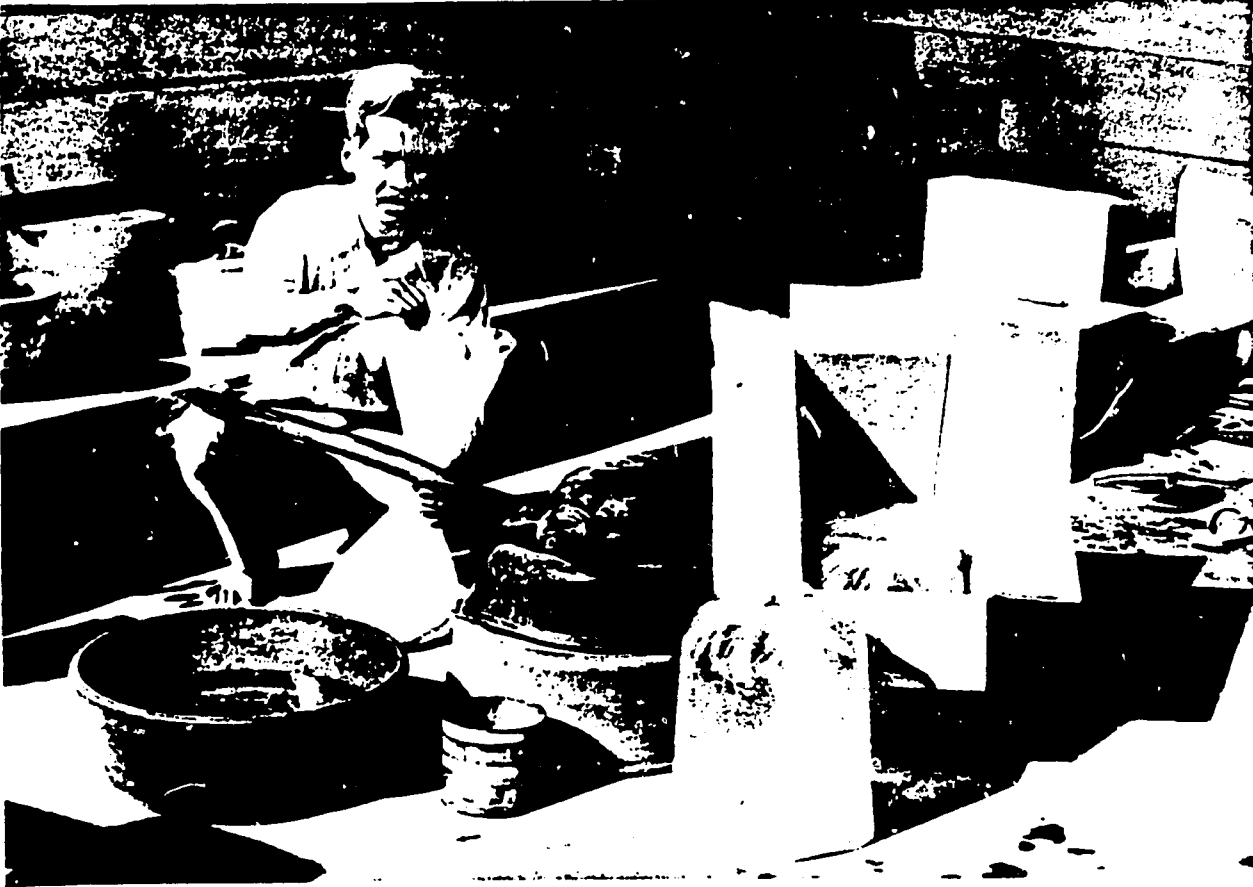
A program to improve milkfish fry capture and distribution methods was conducted in Aceh during the second year. Modified capture gear was given to

selected milkfish fry collectors for testing. Few collectors responded favorably to the modified gear because of the high purchase cost and difficulties in transporting the large gear to and from the collection grounds.

A workshop on fry handling and transporting was held in Banda Aceh in June 1978. Thirty-three representatives of the fisheries service and the fry capture industry participated in the workshop. Improved counting and handling techniques and the use of plastic bags inflated with oxygen for transporting fry were demonstrated as means of decreasing fry mortalities. Fry mortalities of 1-2% were reported by distributors already using plastic bags and oxygen. Distributors using jerry cans without oxygen, the traditional method, reported average fry mortalities of 20-30%. The use of plastic bags with oxygen enables transport of 10,000-11,000 fry in 6 liters of water, compared to 3,000 fry in 15 liters of water when using jerry cans.

Distribution of milkfish fry to regions outside of Aceh began in June 1978 with the establishment of fry marketing between Banda Aceh and Jakarta. Approximately 1.5 million milkfish fry were sold to fish farmers in Java in June-August 1978. Greater expansion of the Java market is expected in 1979, with anticipated sales of 5-10 million fry.

The DGF and the Aceh Fisheries Service have proposed establishing a central fry market in Banda Aceh. It would serve as a collection and auction center for milkfish fry, and would be equipped with aerated holding basins, oxygen, and shipping containers for transporting fry. Such a center would simplify marketing and distribution and reduce mortality of milkfish fry from collectors to farmers.



The use of plastic bags inflated with oxygen to transport fry greatly reduced milkfish fry mortalities between capture and pond stocking.

Pond Fertilization Program

Organic and inorganic fertilizers are used in brackish water fishponds to increase soil and water fertility and to stimulate the production of benthic algal communities as food for milkfish and shrimp. Prior to August 1975, fish farmers could not purchase inorganic fertilizer on the free market in Indonesia for fishpond use. Pre-project discussions obtained a guarantee that inorganic fertilizers would be made available to fish farmers in the free market at Rp. 120/kg. (Rp415 = US \$1.00). At project implementation in October 1976, new GOI policy had made inorganic fertilizers available to fish farmers at the government regulated prices applicable to other agricultural sectors. Prices for urea (Rp. 70/kg), triple super phosphate (Rp. 70/kg), and diammonium phosphate (Rp. 90/kg) were substantially below the project goal of Rp. 120/kg.

In Aceh Province, urea, TSP, and DAP fertilizers are now readily available to fish farmers. Through project demonstrations and promotion, use of these fertilizers was adopted by fish farmers as a management practice to increase fish production. Approximately 1,500-2,000 tons of inorganic fertilizer are now used annually by Aceh fish farmers, surpassing the project goal of 900 tons per year for the two provinces. An estimated 11,800 tons of organic fertilizer (primarily cow manure) are additionally used annually by fish farmers to increase the fertility of ponds. Fertilizer demand is expected to increase proportionally with future production increases. Suppliers of inorganic fertilizers do not anticipate difficulties in meeting the demand; however, organic fertilizers are in short supply and are expected to continue as such.



Project-trained extension agents assist fish farmers in applying new management techniques such as the use of inorganic fertilizers, to increase pond production.

CREDIT ASSISTANCE

Intensified fish production, as opposed to production using traditional methods, requires the use of purchased inputs such as fish fry, fertilizer, pesticides, and labor for pond renovation. Funds for obtaining needed inputs are normally obtained through credit. As a component of the BFP Project, the GOI established a project life (two year) credit line for fish pond loans totaling Rp.891,779,000 (US\$2,151,458) for short-term production, and Rp.329,533,000 (US\$795,014) for capital improvements. These funds were provided by Bank Indonesia and administered through the provincial and local offices of Bank Rakyat Indonesia. Technical assistance to the loan program was provided by the long term advisors, and by a short-term consultant, Dr. E. W. McCoy⁵.

Cumulative credit granted for tambak development in North Sumatra as of 31 July 1978 was Rp.50,375,000 granted to 138 individuals for extensification (construction of new ponds) and Rp.4,000,000 to two individuals for intensification (increasing production in existing ponds). It is expected that during the third year of the North Sumatra sub-project, during which extensification activities are scheduled to begin, there will be an increase in bank credit utilization.

In Aceh, from April 1976 to July 1978, intensification loans totaling Rp.503,861,000 were granted to 576 farmers for approximately 2,005 ha of tambak. A substantially greater amount of credit could have been utilized had it been made available. Credit requirements should be reassessed to bring allocations more closely in line with farmer needs. Credit supervision programs would help to decrease high default rates experienced in some areas of Aceh.

⁵ Associate Professor, Department of Fisheries and Allied Aquacultures, International Center for Aquaculture, Auburn University.



Improved gates, dikes, and pond design in a previously heavily forested pond complex above were made possible through a loan program with Bank Rakyat Indonesia. Fish farmers in Aceh and N. Sumatra Provinces received approximately Rp. 134,226,200 (S1,346,770) in production and capital improvement loans during the BFP project.

Provincial Demonstration and Training Program

Technical assistance to small holder fish farmers was provided through a provincial program utilizing a series of eight government fish farms as demonstration and extension centers. These centers, called Provincial Fishery Demonstration Units (PFDU), provided buildings and improved ponds for demonstrating intensified fish production techniques. At least three farmer training sessions were carried out per year. Forty extension agents, recruited and trained for the BFP project, utilized the PFDUs as their extension base. This report summarizes the PFDU construction and demonstration program and the extension education program during the first two years of the project.

North Sumatra Province

Construction of the Sialang Buah PFDU began in November 1977 and was completed in May 1978. Facilities include a house, a training classroom and eight ponds totaling about 7 ha in surface area. The quality of construction is adequate. Problems remaining include leveling two of the ponds, improving the main gate, drilling a well for freshwater, construction of a storage shed and construction of a bridge for easier access to the site. The unit is staffed with two technicians, two laborers and five extension agents. The extension agents are now undergoing supervised, on-the-job training at the PFDU. Ponds were stocked with milkfish fry in June. In June and July 1978 a training course for all 15 North Sumatra extension agents was held at the unit.

Construction of the Babalan PFDU began in December 1977. The contractor completed work in June 1978. Problems remain, however, which at the present time seriously limit the usefulness of this PFDU. The main dikes and main gate must be higher and wider to withstand high tidal inundations characteristic of the area. To correct this defect earth must be obtained from sources outside

of the site inasmuch as further excavation of the ponds cannot be accommodated. This unit is prone to excessive leakage because of an abundance of organic debris in the soil, which also contributes to excessive and uneven settling of the dikes and occasional collapse of dike sections. This could have been prevented had the topsoil been removed from the dike path before the dike foundation was constructed, and had the dikes been cored with impervious clay. Attempts were made to change the site once it became obvious that many problems would be encountered. However, obstacles to making a change appeared insurmountable from an administrative viewpoint and the decision was made to continue developing the site with a realization of the problems that would be encountered. A considerable amount of development must still be done to make the Babalan PFDU fully operational.

The PFDU originally planned to be built at Perupuk was successfully changed to a more favorable location because of high land elevation and a seasonally interrupted water supply at the original site. Construction at the new site was begun in March 1978 and is approximately 40% complete. Contractor performance at this site has been unsatisfactory.

In all cases construction of PFDUs was slow. This can be attributed to a lack of experience within the provincial Fisheries Service, the provincial Department of Public Works, which was responsible for conducting engineering surveys and making drawings, the contractors, none of whom had previous experience in pond construction, and a construction budget cut by BAPENAS early in the project because of a misunderstanding. Inasmuch as the PFDUs are the operational centers for the project, construction delays had the effect of delaying full implementation of the project.

During construction PFDU staff were assigned to supervise contractor performance and extension agents were assigned to work with the contractors in

order to gain experience in pond construction. Extension agents are still under training and are not yet providing guidance to farmers.

A total of 280 candidate tambak farmers received approximately 1680 man-days of training. In the present fiscal year 1,540 man-days of training and demonstration for tambak farmers, and 1,500 man-days of extension agent visits to tambak farmers, were scheduled and budgeted for three North Sumatra PFDUs.

Aceh Province

Construction of five PFDUs in Aceh was completed in June 1977. Facilities at each PFDU include a house, a storage garage, a training classroom, and approximately 7 hectares of demonstration ponds.

The five Aceh PFDUs were fully operational with a staff of 10 PFDU supervisors, 21 extension agents, and 14 laborers. PFDU operations are conducted in accordance with an annual work plan. Rp.45,757,000 was budgeted by DGF for PFDU operations in Aceh during fiscal years 76/77 and 77/78. Funding was included for pond culture trials, equipment and supplies, vehicle operation and maintenance, staff and farmer training programs, and preparation of extension literature.

Culture trials demonstrating intensified production techniques were conducted at the five Aceh PFDUs beginning in late 1977. Culture trials included milkfish and shrimp monoculture and milkfish/shrimp polyculture. Results of milkfish monoculture trials ranged from an average of 220 kg/ha for fish stocked at 1000/ha to an average of 356 kg/ha for fish stocked at 1500/ha. Length of culture trials was approximately 3 months. Milkfish production of 1,100 kg/ha/yr was demonstrated at Aceh PFDUs using introduced management techniques. Shrimp monoculture trials with P. indicus and P. merguensis demonstrated production approximating 222 kg/ha in 60-75 days at stocking densities of 20,000-30,000/ha.

Difficulties were encountered in controlling stocking densities because of wild shrimp entering during pond filling. Wild shrimp were not eradicated, however, because of their high commercial value.

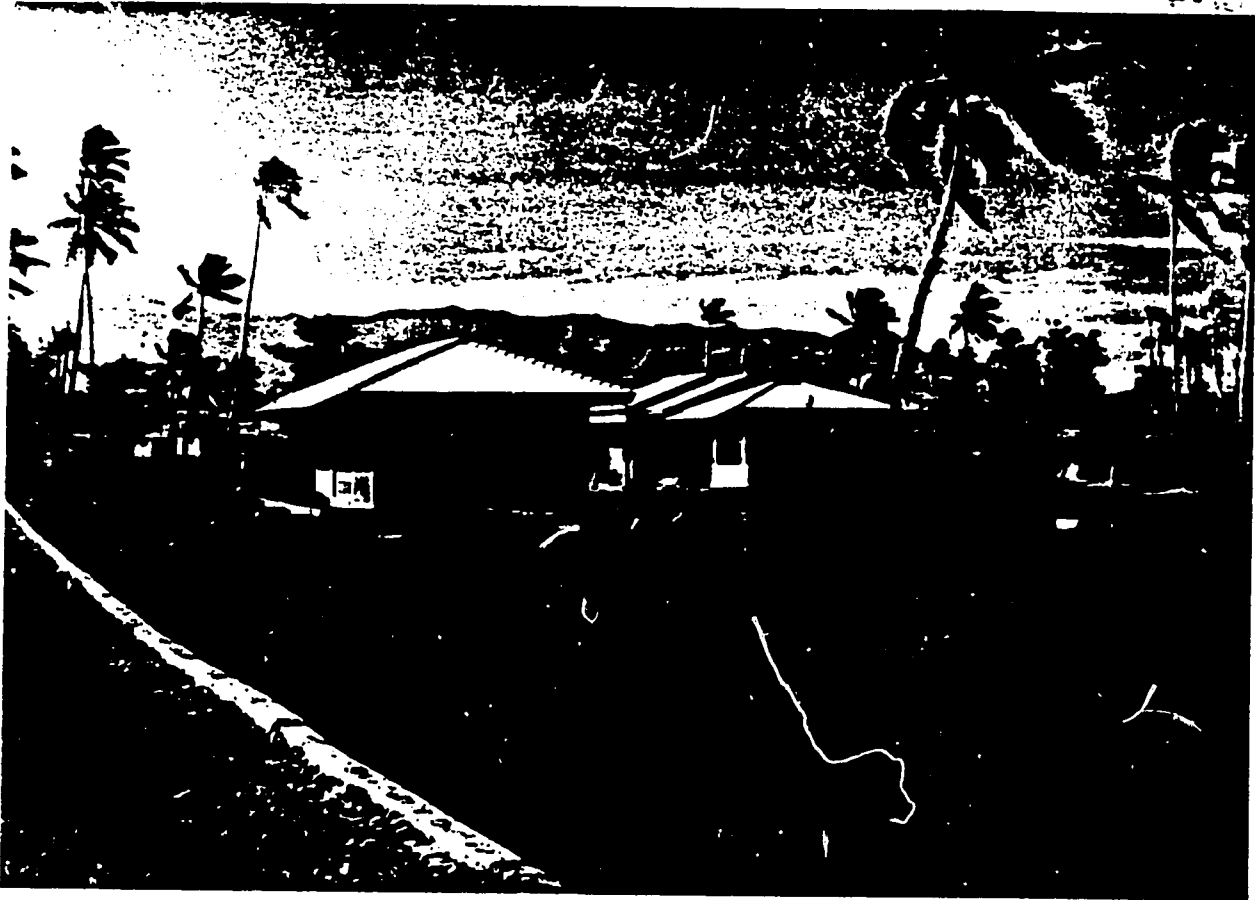
Farmer training sessions began at Aceh PFUDs in July 1977. Monthly training programs were offered at the five PFUDs. A total of 654 farmers received 2,646 man-days of training at the PFUDs. Training programs were 4 days in length and were conducted by PFUD staff and TIAs, with assistance from the provincial director, project officer, PPS (Project Supervisor), and technical advisor. Training programs included method demonstrations, field trips, lectures, use of printed materials, and discussions on pond construction, maintenance, management, culture techniques, fertilization, pest control, and credit. Transportation and living expenses were provided by the project for all participants. Two 2-day workshops, Tambak Production and Marketing, and Fry Handling and Distribution, were also conducted. The workshops were attended by representatives of the fisheries service, Aceh fish farmer associations and milkfish buyers and distributors from throughout Aceh Province. Information was disseminated and demonstrations and discussions held at these workshops to assist producers in expanding post-harvest marketing of milkfish and improving local and interinsular distribution of milkfish fry.

Twenty-one extension agents provided guidance to fish farmers in Aceh. The extension agents were based at the PFUDs and received technical and supervisory assistance from the PFUD and provincial staff. Approximately 17,000 farmer contacts and 9,200 farm visits were made by the extension agents and PFUD staff. Approximately 4,400 additional farmer contacts and 1,350 farm visits were made by the director, project officer, PPS, technical advisor, and other project staff.

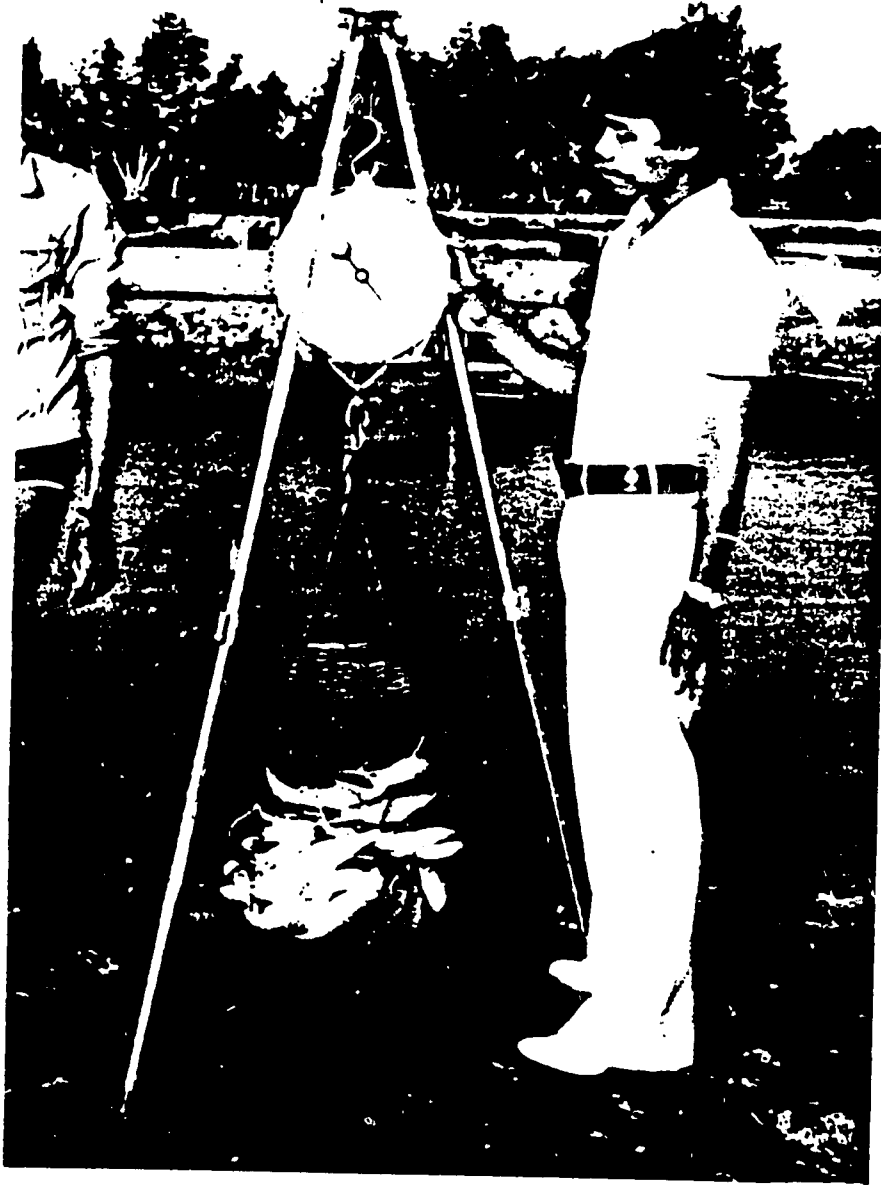
Information on employment in the tambak industry was collected by the PFDU project staff. In North Sumatra, approximately 72.5 man-years of temporary labor have been utilized to date in construction of the three PFDUs. In Aceh, tambak construction and renovation provided approximately 1,100 man-years of labor during the project. The tambak industry provides fulltime employment for approximately 7,423 fish farm owners, 2,300 farm owner family members, 2,560 fish farm caretakers, 500 shrimp processing workers, and 150 marketing workers. Approximately 3,433 fry collectors are employed part-time.



PFDU Gano, Banda Aceh, is one of eight government fish farms constructed for demonstrating improved fish culture techniques to fish farmers in Aceh and North Sumatra Provinces. These PFDUs also serve as bases for extension agents working with individual farmers and local producer associations.



Housing, storage, and training facilities were constructed at each of the PFDUs to allow full-time staff supervision of project activities and to provide classrooms for farmer training programs.



Milkfish (above) and shrimp are sampled at two week intervals during PFDU culture demonstrations to monitor fish growth and to demonstrate improved farm management techniques. Equipment for the BFP project was provided through USAID project funding.



Farmers who participated in the harvest of a demonstration culture trial display 400 gram milkfish cultured in a 3-month period at PFDU Saunodon in Acheh Province. Milkfish production of 1,100 kg/ha/yr was demonstrated through culture trials at the PFDOs.

STAFF TRAINING

Short term training for provincial and field project staff and long term training for DGF core staff were provided under the BFP project. Four long-term participants are currently in training programs for M.S. degrees in the United States (2) and the Philippines (2). Three month training programs in brackishwater fish culture were completed by two provincial management staff in the Philippines. Two other participants completed one month familiarization tours to aquaculture installations in the United States.

Twenty-three project staff (Aceh, 16; North Sumatra, 7) were recruited from the provincial fisheries service for training at the Jepara research station in Central Java prior to the arrival of the Auburn advisors. These project staff each received three man-months of training at the Jepara facility. Training focused on the biology and culture of milkfish and penaeid shrimps. Upon completion of the Jepara training, these staff returned to Aceh and North Sumatra for further training and assignment as demonstration farm (PFDU) supervisors and extension agents (TIAS) for the BFP project.

In Aceh and North Sumatra the PFDU supervisors (16) attended one week intensive courses in farm management, culture techniques, and extension methodology. Training was provided by the provincial fisheries project staffs and the technical advisors. Classroom lectures, method demonstrations, and visits to private fishfarms were included in the training. The PFDU supervisors then returned to their respective assignment sites to supervise construction of the demonstration fishfarms and to assist in training extension agents. Upon completion of the demonstration farms, the PFDU supervisors became responsible for conducting demonstration culture trials and farmer training programs. Periodic two and three day upgrading programs were provided for the PFDU staff during the

project. PFDU staff and other Fisheries Service staff received a total of 287 man-days of formal training from project staff. PFDU staff of both provinces received an additional 139 man-days of training in a 4-day extension methodology program conducted in-country by an Auburn University extension specialist, Dr. H. R. Schmittou, who was consultant to the project from 31 July to 28 August 1977.

Extension agents (TIAs) in both provinces (Aceh, 25; North Sumatra, 15) attended one week intensive courses in fish culture and extension methodology after their appointments to the BFP project. Training was provided by the provincial fisheries project staffs and the technical advisors. In Aceh, extension agents spent an additional month at the PFDU Gano site in Banda Aceh to observe pond construction and fish culture demonstrations. Five TIAs were then assigned to each of the PFDUs for three months of on-the-job training. TIAs assisted PFDU staff during this period in supervising construction of the PFDUs and preparing materials for farmer training programs. TIAs from both provinces received 44.3 man-months of formal training from project staff and 141 man-months of on-the-job training. In the third year extension of the North Sumatra subproject, 180 man-days of additional training for TIAs were scheduled and budgeted, along with 780 man-days of training meetings and consultations for all staff.

Interest has been expressed by the Rector of Syiah Kuala University in Banda Aceh in developing a fisheries education program. It was recommended by project staff that the University, the Dinas Perikanan, and the BPLP extension training center in Sare, Aceh Besar, coordinate efforts to provide vocational training in fisheries and short term advanced training for provincial and kabupaten fisheries staff.



Demonstration farm supervisors and extension agents received training in production, extension, farmer training, and surveying techniques during training programs conducted by the provincial fisheries staff and technical advisors.

PRODUCTION INCREASES

North Sumatra Province

Significant production increases were not accomplished, and were not expected, during the first two years of technical assistance to the project. It is expected, however, that during the third year of the project there will be production increases from existing tambaks. The goal for extensification by the end of the present fiscal year is for 348 ha of tambaks to be under construction. A realistic production potential from this new area is 348 metric tons of milkfish and shrimp per year.

Aceh Province

Tambak production in Aceh before the project began was estimated at 7,765.5 tons annually from 15,848 ha (490 kg/ha/yr). An end-of-project survey by the Aceh fish farmer federation and Aceh fisheries Service estimates current annual production at 12,073.3 tons from 18,196 ha (664 kg/ha/yr). This represents a net increase in marketable products of 4,307.8 tons per year as a direct result of assistance from this project, which exceeds the project production goal of 2258 tons (from 2352 tons to 4610 tons on 4800 ha) by 2050 tons. Approximately 1,170 tons of this production is from new tambaks (extensification).

MARKETING

Understanding the marketing situation and providing solutions is important to project success, in the short-term for intensification and long-term for extensification.

The technology for milkfish culture is comparatively well understood and culture systems are available that have a history of success. Expected production under given conditions can be accurately predicted in most cases. In North Sumatra, however, there has not been a strong tradition of milkfish culture and consumption. Small quantities of milkfish are produced in scattered areas of North Sumatra utilizing traditional methods. A marketing study of milkfish is currently being conducted by the Provincial Fisheries Service. Depending upon the result of this study it has been proposed that market promotion of milkfish be conducted in the Medan area.

Aceh has a tradition of milkfish culture and consumption; however, demand is limited by the small population. Production increases in Aceh would be more rapid if adequate markets for milkfish were available. The production capacity of Aceh tambaks exceeds present demand in the province. Farmers must often sell milkfish at low profit. The Aceh fish farmer federation estimates that 33.4% of the current milkfish production could be exported without limiting local supplies (Table 1).

Efforts to locate export markets for milkfish were not successful. Discussions with marketing representatives from Singapore, Malaysia, Hongkong and Japan indicate export markets are limited. Milkfish have not been promoted in these markets in the past, and marketing agents are hesitant to promote a new product. A large potential market exists in Jakarta, but project staff have been unable to establish shipping linkages between Aceh and Jakarta. It appears,

Table 1. Estimated annual milkfish production and sales data for Aceh Province, 1977/78.

Kabupaten	Milkfish Production (MT/yr)	Local Sales (MT/yr)	Milkfish Available for Export		
			Mt/yr	MT/mo	% Production
Aceh Besar	126.0	126.0	0.0	0	0.0
Pidie	991.9	441.4	550.5	46	55.5
Aceh Utara	5,467.5	3,837.5	1,630.0	136	29.8
Aceh Timor	1,027.2	667.2	360	30	35.0
Total	7,612.6	5,072.1	2,540.5	212	33.4

however, that Jakarta is the best potential outlet for milkfish production from Aceh and North Sumatra.

There are no problems in marketing shrimp. Processors and exporters of shrimp in Aceh and North Sumatra are looking increasingly to tambaks for future shrimp supplies in the face of declining trawler catches from the straits of Malacca. The shrimp that is now produced in tambaks is readily sold to exporters at high prices. Unfortunately the technology for shrimp culture is insufficiently developed to permit extension of reliable, tested information to shrimp farmers. The government thus risks the loss of credibility and the farmer risks loss of his investment. Facilities for field testing and demonstration of shrimp culture techniques, as well as shrimp hatchery facilities, are presently not available on Sumatra.

It is important that decisions and commitments concerning the direction and emphasis of tambak culture (shrimp vs milkfish) be made so that appropriate planning can be done. If milkfish are to be cultured in the region new markets will have to be found. Leadership for new market development outside of the northern Sumatra region should come from the DGF. If shrimp are to be cultured there will be an immediate need for field trial facilities to test shrimp culture techniques and adapt them to conditions in the region. Serious planning should also begin immediately for the development of a shrimp hatchery program for the northern Sumatra region capable of supporting an expanding shrimp production industry.



PRODUCER ASSOCIATIONS

In North Sumatra, two informal producer associations have organized for the purpose of constructing new tambaks. The leadership initiative for formation of the associations was provided by individuals who had attended farmer training programs given by the project. Holdings of association members total approximately 220 ha. Members of one association have already begun work and have made substantial progress in clearing their pond sites. Participants in a farmer training program from another area have expressed interest in forming an association and are presently looking for a suitable site.

In Aceh, fourteen new fish farm owner associations were formed during the project. Four kabupaten level federations of associations and a provincial federation were also formed with project assistance. Aceh currently has 78 producer associations and five federations. Association membership has increased 34%, from 2,341 farmers before the project to 3,135 farmers at present (Table 2). These associations and federations provide assistance to members in purchasing and storing production inputs, distributing technical information, and providing representation at local and provincial government meetings. Project staff have worked directly with these associations to assist farmers to increase production. Association representatives have attended national meetings of importance to the tambak industry, and have taken steps to solve marketing problems currently facing the industry.

Table 2. Number of fish farmer associations in Aceh before and at the end of the project.

Kabupaten	Before Project				End of Project			
	No. of Associations	Farmer Membership	Tambak Area (ha)	No. of Federations	No. of Associations	Farmer Membership	Tambak Area (ha)	No. of Federations
Aceh Besar	4	95	268	-	4	95	268	1
Pidie	22	847	1,697	1	22	919	1,843	1
Aceh Utara	8	349	996	-	22	1,010	2,445	2
Aceh Timor	30	1,050	2,596	-	30	1,111	2,664	1
Total	64	2,341	5,557	1	78	3,135	7,220	5

EXTENSIFICATION

The program of extensification, the emphasis of the North Sumatra sub-project, is targeted with the surveying and identifying of mangrove swamp areas suitable for tambak development and the preparation of a program capable of providing technical assistance to new fish farmers as they are settled on potential tambak lands. The GOI extensification goal for North Sumatra is 2100 ha of tambaks by the end of the next five-year plan (Pelita III), which begins with the next fiscal year (1 April 1979). This goal is a reasonable one and closely approximates our estimate of the project extension capacity when the project is fully operational.

The GOI target group for conversion to coastal fish farming is the under-employed coastal fishermen. These fishermen are among the poorest of the coastal inhabitants in northern Sumatra and there is little potential for improvement for them through increased efforts in the marine capture fishery. The fishery resources of the Malacca Straits are already exploited to their fullest and cannot sustain increased fishing pressure⁶. Fish culture in tambaks offers an alternative source of employment for these fishermen.

Participation in the extensification programs is not limited, however, to coastal fishermen, but is also available to other interested persons. Occupational information obtained from a sampling of training program participants (candidate tambak farmers) revealed the following:

⁶Summary of findings of the Workshop on the Fishery Resources of the Malacca Straits-Parts I and II, 29 March-2 April 1976, Jakarta. UNFAO/UNDP Report.

unemployed*	23
fishermen	18
farmers	16
merchants	6
students/trainees	5
officeworkers	5
farmer/fishermen	4
pensioners	3
laborers	2
journalists	1
fish farmers	1

* Ikut orang tua (Eng. trans. "Work with parents")

Inasmuch as extensification program participants, with very few exceptions, have no background in fish farming, social factors may play an important role in the conversion process.

A major obstacle to extensification is economic, and the limiting economic factor is the cost of pond excavation. In order for a tambak using the benthic algae method of fish food production to be watered sufficiently without excavation, the average high tide must inundate the land surface to a minimum depth of 30 cm. Dikes one meter high are assumed, thus the maximum high tide should not exceed 80 cm above the land surface. Under these conditions 4 ha is the minimum size tambak that will support a farm family of four during the credit repayment period, at an income level of approximately \$201 per capita per annum. Unfortunately the above relationship of land elevation and tidal fluctuation represents a very narrow range of conditions which only a small percentage of land can be expected to have.

With excavation to 20 cm (the cutting depth of the common digging tool), the area of potential tambak is substantially increased. However, under the size limitation of a family tambak (five ha maximum as defined by project paper), and projected tambak productions, it is not economically feasible to excavate 20 cm even if present credit terms were liberalized to permit repayment in ten

instead of five years. In addition there are technical disadvantages to tambak excavation. Excavation removes organic-rich topsoil which would contribute significantly to pond fertility. It exposes potentially acidic subsoil conditions which are common to mangrove formations. Beyond a certain depth of excavation the soil can no longer be added to the dikes and a problem of soil disposal arises.

The most obvious solution to the problem of excavation is to locate areas where excavation is not necessary because of favorable tidal fluctuations and land elevation, however, this land is very limited in area. A second possible solution, which would greatly increase the area capable of being developed into tambak, is pumping. Preliminary indications are that pumping is significantly cheaper than excavation. Pumping is seen only as an interim solution, however, with excavation taking place gradually over a period of several years during which time water is provided by pumping. Before pumping can be recommended appropriate and available pumping equipment must be identified, and economic and technical data obtained through field testing at one of the PFDUs. A pumping specialist consultant will give technical assistance to the project during the third year. A third possible solution, which has yet to be thoroughly investigated, is excavation using heavy earth-moving equipment. A fourth, partial solution, would be a significant easing of credit terms.

Even if one or more of the above possible solutions were implemented the farmers must rapidly develop their management skills and maximize production, as they would still be operating on a very precarious margin during the five-year period of credit repayment.

A major project activity during the second year was surveying mangrove swamp areas to determine their potential for tambak development. This has

involved entering the swamp in boats, and attempting to characterize the land according to soil type, land elevation in relationship to tide, tidal fluctuation and characteristics of the mangrove forest cover. The area was then estimated by eye and from 1:100,000 scale maps. The objective is to eliminate from further consideration areas with no potential for tambak development. Specific areas with potential will be evaluated in greater detail as interest in tambak development is expressed by the local people. Conducting of the survey is slow due to the difficulty of reaching some areas and moving about in them. A motorized boat is available for part of the survey, however oar-powered boats are used most of the time.

A total of 14,385 ha were surveyed (28.8% of total available mangrove estimated for North Sumatra); 3,970 ha (27.6% of land surveyed) were identified as having potential for tambak development; 7755 ha (53.9% of land surveyed) were identified as having potential for tambak development if irrigation by pumping were utilized; 2,720 ha (18.9% of land surveyed) were considered to have no potential for tambak development.

A second major obstacle for extensification is the difficulty of obtaining land certification and titling that is acceptable to the banks as collateral for credit. The problems encountered by applicants have been lack of adequate information about application procedures, high administrative costs, and length of time required for processing. A working group was formed within the Provincial Fisheries Service to study the problem and recommend actions to be taken to solve the problem.

An estimated 1152 ha of existing tambak are reported from North Sumatra. Intensification of these tambaks, as with extensification, depends upon solving problems of land certification so that credit can be made available for renovation and production inputs. Surveys are being planned to gather relevant data concerning existing tambaks.



A total of 14,385 hectares of mangrove swamp area was surveyed as part of the extensification project in North Sumatra Province. The program of extensification identifies swamp areas suitable for tambak development and provides technical assistance to new fish farmers as they settle on potential tambak lands.