
**Brackishwater
Aquaculture
Development
in Northern
Sumatra,
Indonesia**



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COVER PHOTO. Milkfish are sampled at 2-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.

Information contained herein is available to all without regard to race, color, or national origin.

Brackishwater Aquaculture Development in Northern Sumatra, Indonesia

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INTRODUCTION

THE GOVERNMENT OF INDONESIA (GOI) 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 (Bryan L. Duncan)², and Banda Aceh, Aceh (Michael C. Cremer), from November 1, 1976, to September 1, 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 hectares of brackishwater ponds in Indonesia, located mainly along the north coasts of Java, South Sulawesi, and Sumatra. Production in these ponds had reached a plateau with the use of traditional methods, and new and more productive technology was not being adopted. During the Pelita I development program (1969-74), the Government of Indonesia concentrated efforts to improve brackishwater pond fisheries, by using these two steps:

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

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 (1974-79), 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 USAID to appraise the idea, and in November 1974 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 The next year (1976) Auburn University's International Center for Aquaculture received a 2-year contract from USAID to assist the 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 instituted.

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) made operational with technical assistance.

5. Trained staff functioning with technology and methodology for intensification outreach program.

6. Annual production from 4,800 hectares of existing tambaks doubled, from approximately 500 kilograms to 1,000 kilograms per hectare per year.

7. New employment created for agricultural and fishery families.

8. Increased number and greater development roles achieved for local producer associations.

9. GOI infrastructure in place and functional to handle remaining intensification and projected expansion.

This report outlines progress toward achieving these objectives during the initial 2-year project.

FRY RESOURCE EVALUATION

Fry supplies to support the brackishwater 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. The goals were to increase the volume of fry catch sufficient to double production and to improve handling and distribution methods so that 20 percent more of the captured fry reached the terminal market.

In North Sumatra Province, surveys in 1974-76 by fishery

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

³Resident advisor for the International Center for Aquaculture to the USAID sponsored Inland Fisheries Project in the Philippines.

⁴D. D. Moss, E. W. McCoy, J. H. Grover, and J. R. Snow, of the International Center for Aquaculture, Auburn University, served as technical consultants on the project development team.



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

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 1976-78 confirmed a lack of milkfish fry in the North Sumatra area. Evaluation of shrimp postlarvae resources, however, indicated abundant juvenile shrimp along the coast. Shrimp surveys were conducted periodically throughout the project, combined with training programs for fishermen to teach gear construction, capture techniques, and handling and selection of postlarvae. Approximately 1,115 man-days of effort were utilized in the 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.

Milkfish fry surveys conducted in Aceh Province during 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, Pulau Weh, Pulau 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 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 that province.

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 survey of juvenile shrimp was conducted in Aceh by BFP project staff in 1977. Shrimp juveniles were found in coastal waters of four kabupatens. Species identified were *Panaeus 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 percent 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 high purchase cost and difficulties in transporting the larger 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. 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 percent 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 percent. The use of plastic bags with oxygen enables transport of 10,000-11,000 fry in 6 liters of water, compared with 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. 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.

POND FERTILIZATION PROGRAM

Organic and inorganic fertilizers are used in brackishwater 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 per kilogram (Rp. 415 = 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 and triple superphosphate (Rp. 70 per kilogram each) and diammonium phosphate (Rp. 90 per kilogram) were substantially below the project goal of Rp. 120 per kilogram.

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. In addition, some 11,800 tons of organic fertilizer (primarily cow



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

manure) are used annually 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 so.

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 (2-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, E. W. McCoy.⁵

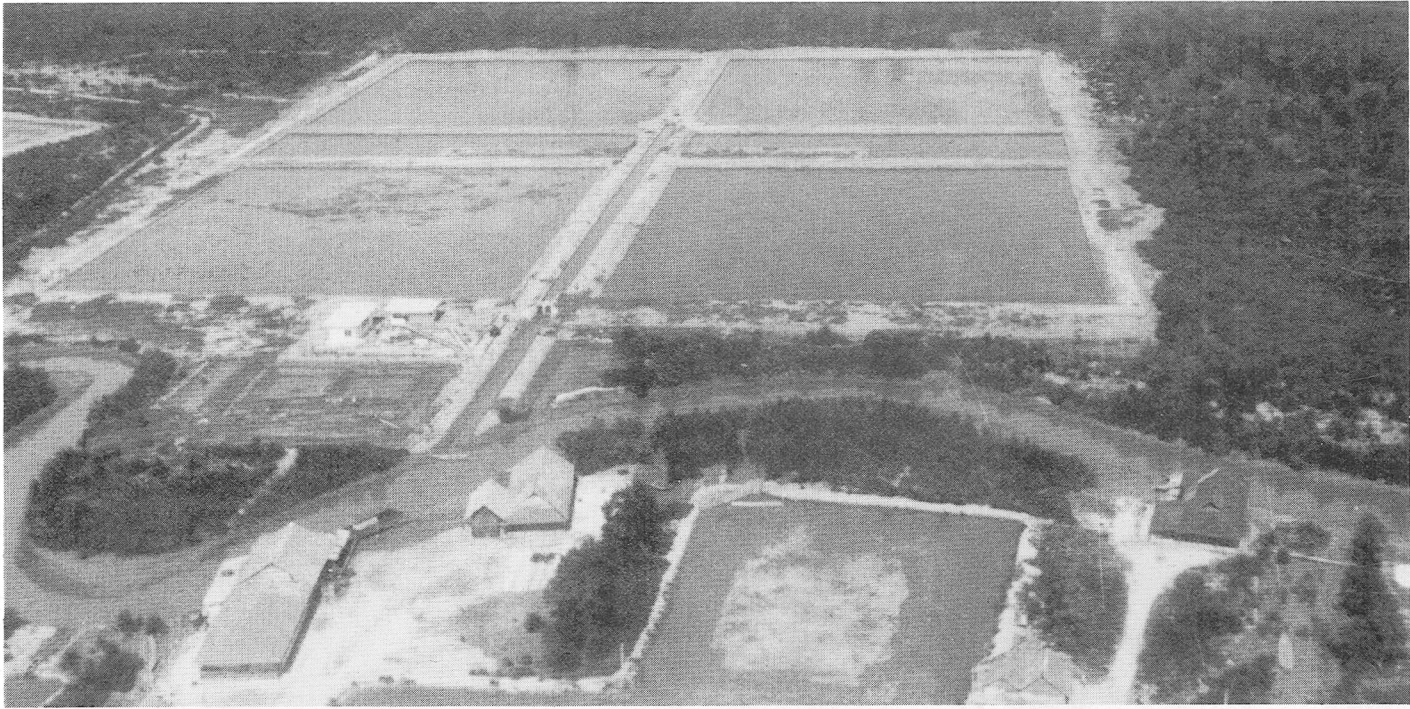
Cumulative credit granted for tambak development in North Sumatra as of July 31, 1978, was Rp.50,375,000 granted to 138 individuals for expansion (construction of new ponds) and Rp.4,000,000 to two individuals for intensification (increasing production in existing ponds). It is expected that during the third year of the North Sumatra sub-project, during which expansion 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 hectares 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.

⁵Associate 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 were made possible through a loan program with Bank Rakyat Indonesia. Fish farmers in Aceh and North Sumatra provinces received approximately Rp. 558,236,000 (\$1,346,770) in production and capital improvement loans during the BFP project.



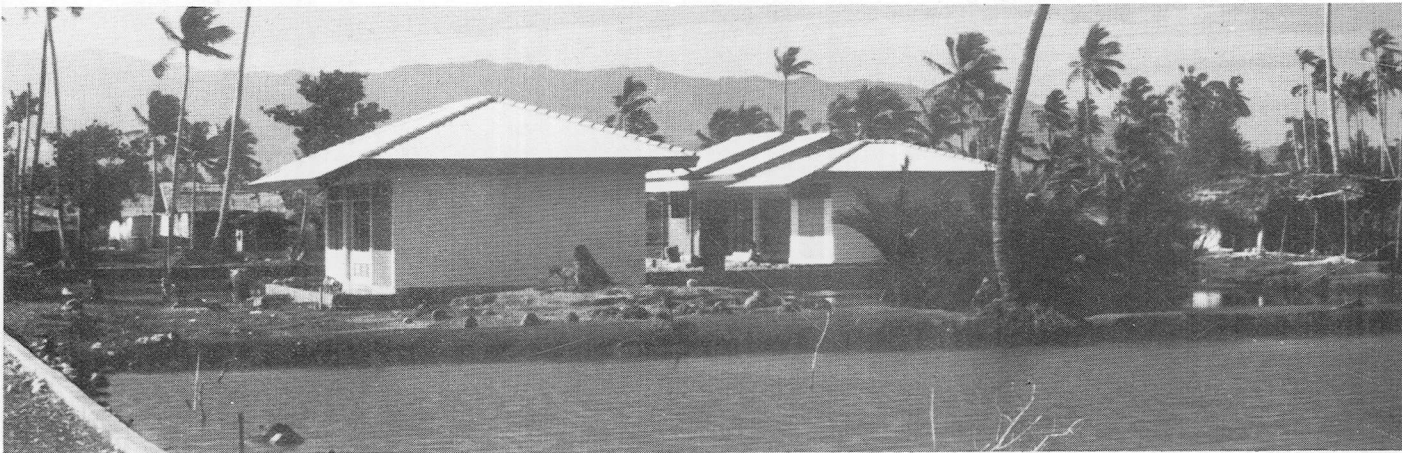
PFDU Sialang Buah in North Sumatra is one of eight government fish farms constructed for demonstrating fish culture techniques to fish farmers in Aceh and North Sumatra provinces. These PFDUs, ranging from 6 to 7.5 hectares in water surface area, also serve as bases for extension agents working with individual farmers and local producer associations.

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 (PFDUs), 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 2 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 hectares 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.



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.

Construction of the Babalan PFDU began in December 1977. The contractor completed work in June 1978. Problems remain, however, which 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 the ponds cannot be further excavated. 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 formation 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. Obstacles to making a change appeared insurmountable from an administrative viewpoint, however, and the decision was made to continue developing the site with a realization of the problems that would be encountered. Considerable development must still be done to make the Babalan PFDU fully operational.

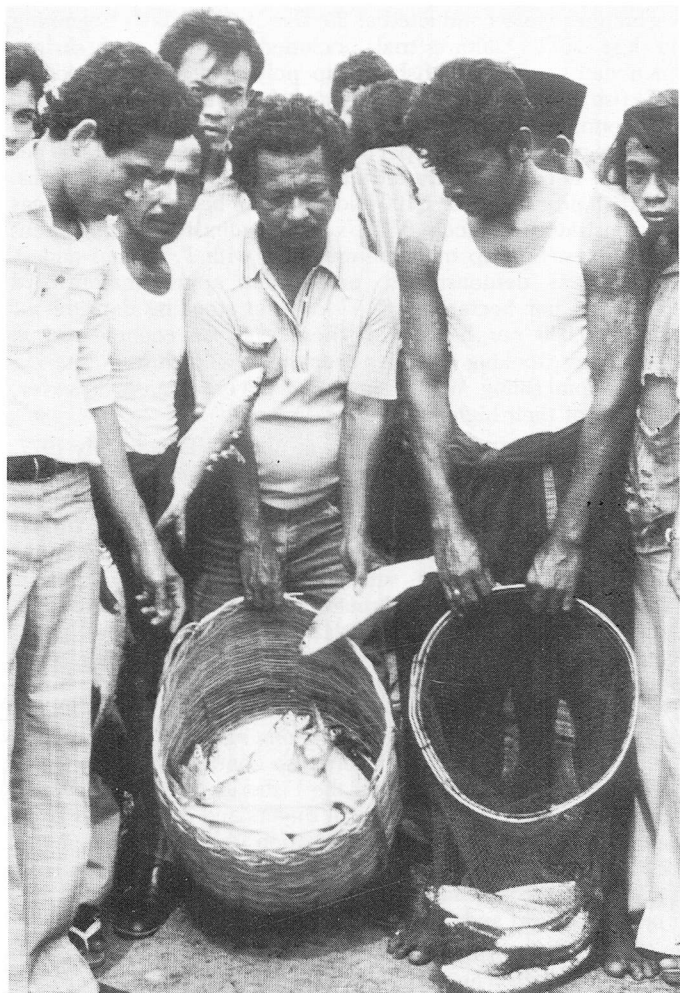
The PFDU originally planned to be built at Perupuk was successfully changed to a more favorable location because of high land elevation and a seasonally interrupted water supply at the original site. Construction at the new site was begun in March 1978 and is approximately 40 percent complete. Contractor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

Construction of all PFDUs has been slow, for three reasons: (1) a lack of experience within the provincial Fisheries Service and the provincial Department of Public Works, which was responsible for conducting engineering surveys and making drawings; (2) inexperience of the contractors, none of whom had previous experience in pond construction; and (3) cutting of the construction budget by BAPENAS (Indonesian National Planning Board) 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



A fish farmer receives technical assistance from his area extension agent and the BFP project supervisor during construction of a new concrete water gate for his tambak. Project staff made more than 10,000 individual farm visits to fish farmers in Aceh and North Sumatra between 1976 and 1978.



Farmers who participated in the harvest of a demonstration culture trial display 400-gram milkfish cultured in a 3-month period at PFDU Seunodon in Aceh province. Milkfish production of 1,100 kilograms per hectare per year was demonstrated through culture trials at the PFDUs.

contractor performance and extension agents were assigned to work with the contractors 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 1,680 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 were conducted in accordance with an annual work plan. A total of Rp.45,757,000 was budgeted by DGF for PFDU operations in Aceh during fiscal years 1976-77 and 1977-78. 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 PFUDs beginning in late 1977. Culture trials included milkfish and shrimp monoculture and milkfish-shrimp polyculture. Production in milkfish monoculture trials ranged from an average of 220 kilograms per hectare for fish stocked at 1,000 per hectare to an average of 356 kilograms per hectare for fish stocked at 1,500 per hectare. Length of culture trials was approximately 3 months. Milkfish production of 1,100 kilograms per hectare per year was demonstrated at Aceh PFUDs using intensive management techniques. Shrimp monoculture trials with *P. indicus* and *P. merguensis* demonstrated production approximating 222 kilograms per hectare in 60-75 days at stocking densities of 20,000-30,000 per hectare. 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. The 4-day training programs were conducted by PFUD staff and TIAs, with assistance from the provincial director, project officer, 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. These 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 interisular 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. In addition, the director, project officer, project supervisor, technical advisor, and other project staff made approximately 4,400 farmer contacts and 1,350 farm visits.

Information on employment in the tambak industry was collected by the PFUD project staff. In North Sumatra, approximately 72.5 man-years of temporary labor have been utilized to date in construction of the three PFUDs. In Aceh, tambak construction and renovation provided approximately 1,100 man-years of labor during the project. The tambak industry provides full-time 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.

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, two in the United States and two in the Philippines. Three-month training programs in brackishwater fish culture were completed by two provincial management staff in the Philippines. Two other participants completed 1-month familiarization tours to aquaculture installations in the United States.



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.

Twenty-three project staff (16 in Aceh and 7 in North Sumatra) 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. Each of these received 3 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 (PFUD) supervisors and extension agents (TIAs) for the BFP project.

The 16 PFUD supervisors in Aceh and North Sumatra attended 1-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 fish farms were included in the training. The PFUD supervisors then returned to their respective assignment sites to supervise construction of the demonstration fish farms and to assist in training extension agents. Upon completion of the demonstration farms, the PFUD supervisors became responsible for conducting demonstration culture trials and farmer training programs. Periodic 2- and 3-day upgrading programs were provided for the PFUD staff during the project. PFUD staff and other Fisheries Service staff received a total of 287 man-days of formal training from project staff. PFUD 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, H. R. Schmittou, who was consultant to the project from July 31 to August 28, 1977.

Extension agents (TIAs) in both provinces (25 in Aceh and 15 in North Sumatra) attended 1-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 PFDU for 3 months of on-the-job training. TIAs assisted PFDU staff during this period in supervising construction of the PFDU 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 Fisheries Service, and the 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.

PRODUCTION INCREASES

North Sumatra Province

Production increases were not expected during the period of technical assistance to the project in North Sumatra. The goal for expansion, the emphasis of the project in North Sumatra, is for 2,100 hectares of tambak to be constructed and operational by the end of Pelita III (1979-84). By the end of year one of Pelita III it is expected that 300 hectares will be under construction with a portion completed and production cycles begun. As new tambaks become operational, a production of 1,000 kilograms per hectare per year of milkfish and shrimp can be expected, as has been convincingly demonstrated in the Philippines, in Aceh at the PFDU, and in instances of well-managed private tambaks.

By the end of Pelita III, tambak production from 2,100 hectares in North Sumatra is expected to be 2,100 tons per year (1976 pre-project production was 206.1 tons). This will represent new, full-time employment for approximately 525 families, with an annual income of about Rp.800,000 per family after operation costs, and employment for 1,050 hired laborers.

Aceh Province

Tambak production in Aceh before the project began was estimated at 7,765.5 tons annually from 15,848 hectares (490 kilograms per hectare per year). 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 hectares (664 kilograms per hectare per year). 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 by 2,050 tons the project production goal of 2,258 tons. Approximately 1,170 tons of this production are from new tambaks (expansion).

The 4,308 tons of new tambak production already realized in Aceh provides 10 kilograms of fish for 430,800 persons (or the equivalent thereof), increasing per capita consumption from the present 20 kilograms to 30 kilograms (minimum WHO standard for animal protein consumption). This production represents additional income to tambak farmers of Rp.1,292,400,000 (@Rp.300 per kilogram). Total USAID funding to the project is \$606,000, or \$0.14 per kilogram for the fish production increase as a direct result of the project. This cost will be significantly reduced as longer-term aspects of the project pay off in North Sumatra and Aceh.

MARKETING

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

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 by traditional methods in scattered areas of North Sumatra. A marketing study of milkfish is currently being conducted by the provincial Fisheries Service. Depending on 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, but 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 one-third of the current milkfish production could be exported without limiting local supplies, table 1.

Efforts to locate export markets for milkfish have not been promising to date. Discussions with marketing representatives from Singapore, Malaysia, Hongkong, and Japan indicate that export markets are at present 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 not yet been successful in establishing shipping linkages between Aceh and Jakarta. It appears, 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

TABLE 1. ESTIMATED ANNUAL MILKFISH PRODUCTION AND SALES DATA FOR ACEH PROVINCE, 1977-78

Kabupaten	Milkfish production per year	Local sales per year	Milkfish available for export		
			Per year	Per month	Percent of production
	Tons	Tons	Tons	Tons	Pct.
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	360.0	30	35.0
TOTAL	7,612.6	5,072.1	2,540.5	212	33.4



Milkfish is traditionally sold by the piece (250-400 grams per fish) in local markets in Aceh and North Sumatra. While improved production technology is being adopted by local farmers in these areas, the establishment of marketing links with the major consumer areas in Java has not occurred. Thus, marketing is currently the major constraint to continued expansion of the milkfish industry on Sumatra.

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. Such facilities have been recommended and are under consideration.

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 must be developed. 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 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

Two informal producer associations have organized in North Sumatra for the purpose of constructing new tambaks. Initiative for the formation was provided by individuals who had attended farmer training programs given by the project. Holdings of association members total approximately 220 hectares. 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, 14 fish farm owner associations were formed during the project. Four kabupaten level federations of associations and a provincial federation also were formed with

project assistance. Aceh currently has 78 producer associations and five federations. Association membership has increased 34 percent, 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.

EXPANSION PROGRAM

The program of expansion, the emphasis of the North Sumatra subproject, is targeted with surveying and identifying mangrove swamp areas suitable for tambak development and preparing a program capable of providing technical assistance to new fish farmers as they are settled on potential tambak lands. The GOI expansion goal for North Sumatra is 2,100 hectares of tambaks by the end of the next 5-year plan (Pelita III), which begins with the next fiscal year (April 1, 1979). This goal is a reasonable one and closely approximates the authors' 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 pressure.⁶ Fish culture in tambaks offers an alternative source of employment for these fishermen.

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

Status	No.
Unemployed*	23
Fishermen	18
Farmers	16
Merchants	6
Students/trainees	5
Officeworkers	5
Farmers/fishermen	4
Pensioners	3
Laborers	2
Journalists	1
Fish farmers	1

*Ikut orang tua (English translation—"work with parents").

Inasmuch as most expansion program participants have no background in fish farming, social factors may play an important role in the conversion process.

A major obstacle to expansion is economic, and the limiting economic factor is the cost of pond excavation. 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 centimeters. Dikes 1 meter high are assumed, thus the maximum

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

TABLE 2 NUMBER OF FISH FARMER ASSOCIATIONS IN ACEH BEFORE AND AT THE END OF THE PROJECT

Kabupaten	Before project				End of project			
	Associa- tions	Farmer member- ship	Tambak area	Feder- ations	Associa- tions	Farmer member- ship	Tambak area	Feder- ations
	No.	No.	Ha	No.	No.	No.	Ha	No.
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

high tide should not exceed 80 centimeters above the land surface. Under these conditions 4 hectares is the minimum size tambak that will support a farm family of four during the credit repayment period, at an income level of approximately \$210 per capita per annum. Unfortunately, the above relationship of land elevation and tidal fluctuation represents a narrow range of conditions which only a small percentage of land can be expected to have.

With excavation of 20 centimeters (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 (5 hectares maximum as defined by project paper) and projected tambak productions, it is not economically feasible to excavate 20 centimeters even if present credit terms were liberalized to permit repayment in 10 instead of 5 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, such land is limited in area. A second possible solution, one 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 to assure success. They would still be operating on a precarious margin during the 5-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 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, but oarpowered boats are used most of the time.

A total of 14,385 hectares was surveyed (28.8 percent of total available mangrove estimated for North Sumatra). Of this total, 3,970 hectares (27.6 percent) were identified as having potential for tambak development, 7,755 hectares (53.9 percent) as having potential for tambak development if irrigation by pumping were utilized, and 2,720 hectares (18.9 percent) were considered to have no potential for tambak development.

A second major obstacle for expansion 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 1,152 hectares of existing tambak are reported from North Sumatra. Intensification of these tambaks, as with expansion of production units, depends on 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 expansion project in North Sumatra province. The program of expansion identifies swamp areas suitable for tambak development and provides technical assistance to new fish farmers as they settle on potential tambak lands.

