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Technology Verification Studies for RP Formulated

Implementation Planned for Second Half of 1979

Twelve studies covering the four major aquaculture industries of the Philippines – milkfish, prawn, tilapia and molluscs – have been identified, are being finalized, and scheduled for implementation towards the lower half of this year. Three are on milkfish, two on prawns, one on *Artemia salina* which is an essential larval feed for prawn and milkfish, three on tilapia, and three on mussels and oysters.

Under milkfish are the following studies: (1) multi-size stocking and manipulation in milkfish culture; (2) field testing of milkfish pen culture technology in shallow water; and (3) stunting of milkfish fry and fingerlings.

Prawn studies will be in the production of spawners particularly the technology for maturation by eyestalk ablation, and larval rearing. A milkfish-prawn category study is the production of brine shrimp or *Artemia salina* in ponds and salt beds.

Those identified for tilapia are: 1) field testing of tilapia culture technologies in ponds and in cages; (2) seed production of *T. nilotica;* and (3) sex reversal in *T. mossambica.*

Studies on molluscs will deal on the (1) transfer of oyster farming technology from producer regions to non-producer regions; (2) establishment of a pilot mussel farm in areas without spatfall using transplanted spats; and (3) testing of available post harvest technology and handling, transporting and marketing mussels from the source of Metro Manila markets.

SEAFDEC researchers involved in the formulation, design and implementation of the aquaculture technology vertification studies discuss refinements of the studies and possible implementation approaches with AIA deputy director H. Chaudhuri (center). They are (l-r) Fred Yap, leader of the mollusc project team; Chhorn Lim, fish nutrition specialist and head of the Department's nutrition laboratory; Chaudhuri; Jurganne Primavera, head of the prawn land-based broodstock development project and in-charge of the brine shrimp studies; and Rolando Platon, leader of the barangay hatchery project.

Identification Mechanism

These initial 12 verification studies were sifted from about 45 capsule study proposals submitted by participants of the February 1979 aquaculture technology consultation workshop sponsored by the SEAFDEC Aquaculture Department and the Philippine Council for Agriculture and Resources Research.

In that workshop, the participants among other things, consolidated all available technology on the four commodities, identified the technology gaps,

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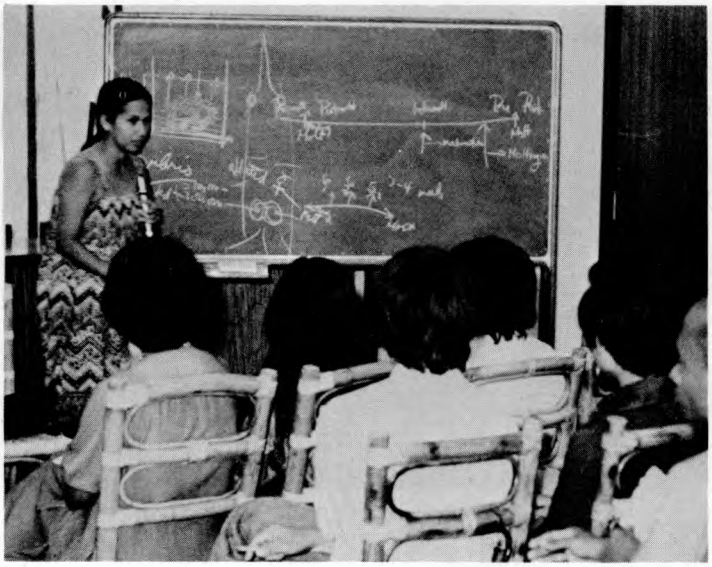
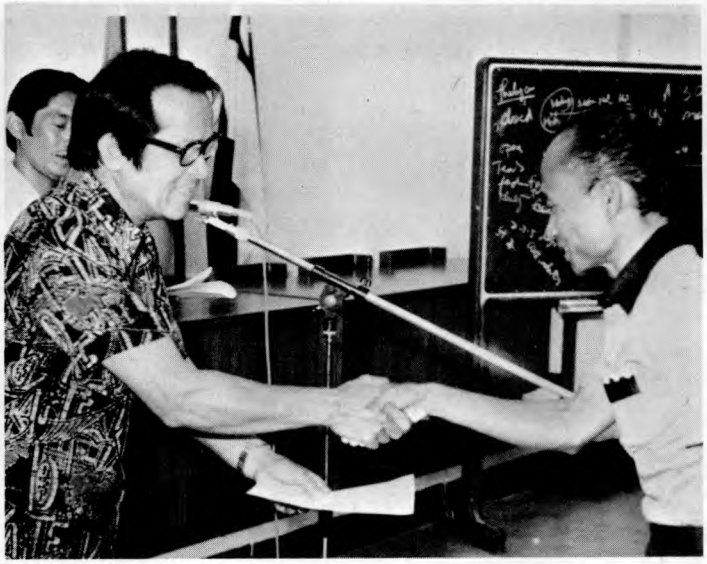




International Training Goes on High Gear

Participants of the recently concluded 4-week prawn hatchery management and operations training which included workers from Thailand, Malaysia, Singapore, Indonesia and the Philippines, engage in a wrap-up discussion-open forum with SEAFDEC researcher-lecturer J. H. Primavera on prawn broodstock development, spawner maturation and rematuration techniques and other essential procedures. At right, hatchery trainee receives certificate from AIA deputy director Thomas G. Flores. The 3-month aquaculture (milkfish) management program which concurrently started with the prawn hatchery course has moved on to the field practice phases.

Meanwhile thirteen Cuban fishery technologists have arrived to train in a special course arranged for them which covers aquaculture management, engineering, and milkfish culture management, and tilapia culture. Of the 13, five are in the freshwater fisheries station training in tilapia. Also, 13 participants coming from Southeast Asian countries have started their training on fish pond engineering.

The Aquaculture Department main station's life support system gets a big lift with the completion on May 23 of the freshwater pipeline which will shortly supplant the current water system that relies on numerous shallow wells and electrically operated individual pumps.

Available Technology and Technology Gaps in Tilapia Farming in the Philippines

Technologies for Population Control of Tilapia in the Philippines.

Existing technologies already in use are monosex culture, sex reversal technique and cage culture. Application of these techniques reduced the population of undesirable fish and increased significantly the yields of marketable-size tilapia.

Other methods that are still under evaluation are hybridization and use of piscivorous fish species as biological control.

A cross between male *T. aurea* and female *T. nilotica* has been tried which yielded 75% male hybrids. Use of mudfish *(Ophicephalus striatus)* and catfish *(Clarias batrachus)* to serve as biological control was tried but there were problems such as poor recovery of the predator at harvest attributed to cannibalism and escape. In brackishwater, tenpounder and tarpon used as biological controls for controlling reproduction of *T. mossambica* have shown promising results.

Technology gaps

1. Development of practical and economical facilities where artificially sex-reversed fry of tilapia can be mass-produced;
2. Evaluation of other species of piscivorous species as biological control for tilapia reproduction;
3. Techniques to maintain pure strain of desired tilapia for hybridization purposes particularly aiming at producing all-male tilapia; and
4. A more systematic and faster way of separating sexes.

Tilapia Nutrition Under Freshwater Conditions.

Nutrition studies on tilapia under freshwater conditions were reviewed.

STATUS OF AVAILABLE TECHNOLOGIES AND PRODUCTION POTENTIAL FOR TILAPIA CULTURE IN THE PHILIPPINES

Technology	Experimental	Verification/ Field Testing	Potential Yield (kg/ha/yr)
Population Control of Tilapia			
1. Monosex culture of *T. mossambica*		x	4,000
2. Sex reversal of *T. mossambica*		x	3,000
3. Biological control of *T. mossambica* with piscivorous fishes in brackishwater		x	2,000
4. Cage culture of *T. nilotica* in freshwater		x	240 kg/m^3/yr
5. Hybridization	x x		
Pond Culture of Tilapia			
1. Culture of *T. nilotica* in freshwater ponds with fertilization only		x	4,000
2. Culture of *T. nilotica* in freshwater ponds with fertilization & supplemental feeding		x	6,000
Lake farming of tilapia in cages	x		
Diet development for tilapia	x		
Hatchery			
1. Fishpond *(T. nilotica)*		x	7 fry/m^3/month
2. Fish paddies *(T. nilotica)*		x	14 fry/m^3/month
3. Net enclosures			
a. *T. nilotica*		x	250 fry/m^3/month
b. *T. mossambica*		x	2,500 fry/m^3/month

Two approaches in feeding tilapia at the Central Luzon State University were given as follows: feeding of materials that will supplement what is already available, and complete feeding of fish stocked at high densities in cages, raceways, pen and ponds.

Some major research findings on tilapia nutrition are: (1) protein requirement of *T. mossambica* fry, fingerlings and all-male were 38-45%, 30-38% and

(Continued on page 6)

The Use of Aquatic Plants as Feed for *Tilapia Nilotica* in Floating Cages

ABSTRACT

Three kinds of aquatic plants, namely, *Hydrilla verticillata, Lemna minor,* and *Chara* sp. were used as feed for the *Tilapia nilotica* reared in floating cages at three levels of stocking densities: 5, 15, and 45 fishes per cage.

Results of the study showed that *Lemna minor* gave the best effect on growth rate of the fish in every level of stocking density.

Feed conversion rate ranged from 19 to 33; *Lemna minor* was the lowest (33:1), while *Chara* sp. was the highest (19:1).

INTRODUCTION

Tilapia nilotica was introduced to Indonesia from Taiwan in 1969 by the Research Institute for Inland Fisheries of Indonesia. It has been transplanted to 21 provinces in the country.

The Government of Indonesia has chosen this species as one of the commodities to be promoted for a non-commercial fish programme. Some hatcheries have taken part to produce seed of Nila (local name of *T. nilotica)* to be distributed to local people.

Rearing *T. nilotica* in impounding net has also been tried by the Inland Fisheries Research Station in Lake Jatiluhur, West Java. Bamboo cage culture and pen culture of *T. nilotica* has been done on an experimental basis by the Aquaculture Department, Faculty of Agriculture, Padjadjaran University, in Curug water-reservoir, West Java.

The use of cage for culturing common carp *(Cyprinus carpio)* is very popular especially in West Java, and since the last world war, has become an established industry (Djajadiredja and Jangkaru, 1977).

The use of aquatic plants as feed for *T. nilotica* in floating cages is discussed in this paper.

MATERIALS AND METHODS

The experiment was conducted from March to June 1978 at Curug water-reservoir, Kecamatan of Klari, Kabupaten of Karawang, West Java Province. The water temperature ranged from 28.0 to 31.5°C, and the pH ranged from 6.0 to 7.5.

The cages used for rearing the fish were $2m^3$ (2 x 1 x 1 m) made of split bamboo nailed to a wooden frame. Inside the cage, polyethylene net with mesh size of 0.3 cm was used for doubling the cage. This net could be easily pulled out for sampling purposes. Supported by bamboo poles, each cage was floated in the water to get a water volume of 1 m^3. The average depth of water was 1.5 m. The total number of cages used in this experiment was 27, separated into three blocks of nine cages. The feed treatments were of three levels: *Hydrilla verticillata, Lemna minor,* and *Chara* sp., while the stocking densities were also of three levels: 5, 15 and 45 fishes per cage. The aquatic plants as feed were given every day at a quantity of at least 30% of the total weight of the stock.

The *Tilapia nilotica* used in this experiment had an average weight of 170 g.

The total number of feed consumed by the fish was determined by subtracting the unconsumed feed from the total number of feed given.

RESULTS AND DISCUSSION

Under cage culture condition, the use of aquatic plants as feed for *T. nilotica* was relatively effective.

Growth rate of the *T. nilotica* fed with *Lemna minor* was the fastest, while those fed with *Hydrilla verticillata* or with *Chara* sp. registered an almost equal rate. *T. nilotica* prefers *Lemna minor* to the other two species, the result indicates.

According to some investigators, *Lemna minor* was one of the aquatic plants which could be easily consumed by herbivorous fish, especially by grass carp *(Ctenopharyngodon idella).*

Hydrilla verticillata and *Chara* sp. have a relatively "hard" structure compared with *Lemna minor* which has a relatively "soft" structure.

Lemna minor gave the lowest water content and the highest protein content in the fish flesh of *T. nilotica,* while *Chara* sp. gave the highest water content and the lowest protein content. *Hydrilla verticillata* gave a "moderate" water content and protein content, but gave the highest fat content.

Feed conversion rate of *Lemna minor* was the lowest (33 g of feed was needed to produce 1 g of fish flesh), *Hydrilla verticillata* was higher, while *Chara* sp. was the highest. Although the conversion rate of *Lemna minor* was low, the growth rate of fish was relatively faster because of high preference of the fish to this plant even with the highest stocking rate.

Contributed by Sjamsudin Adang Rifai of the Aquaculture Department, Padjadjaran University, Indonesia.

Growth rate of the fish was affected by the rate of stocking; the lower the density, the higher the growth rate. There was no interaction between feed and rate of stocking treatments.

The rate of stocking level used in this experiment was relatively low as indicated by ratio of percentage of growth rate in every level of density, in other words the carrying capacity of the cage was not fully utilized. Further investigation to see the optimum density is needed.

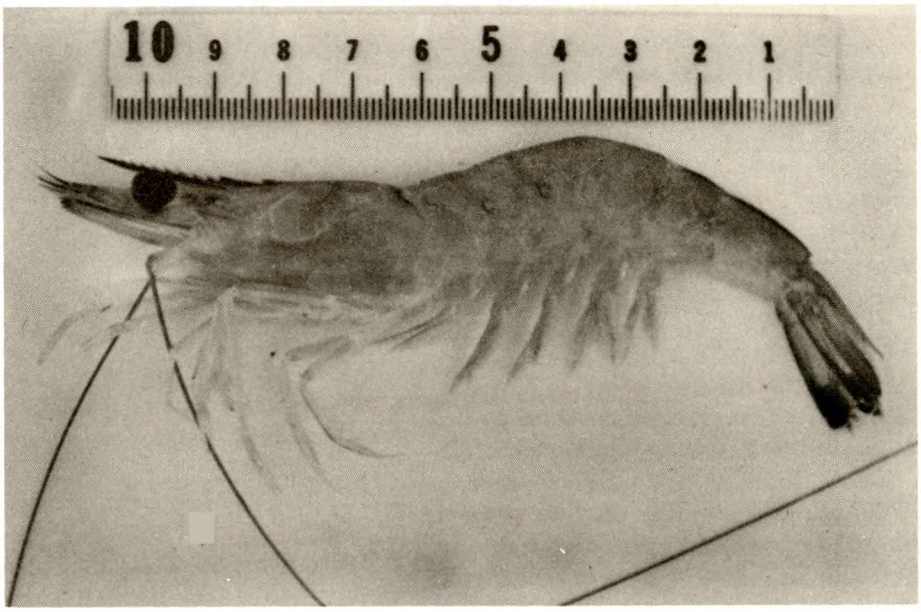
Using aquatic plants as feed for cultured fish is recommendable since it may be useful for the control of aquatic weeds. But because of the low rate of conversion of the aquatic plants as feed, supplemental feed should be considered. The role of supplemental feeding in culturing *T. nilotica* either in pond or cage had been discussed by some authors.

In this experiment, the economic aspect of cage culture using aquatic plants as feed was not considered.

CONCLUSION AND RECOMMENDATIONS

1. Although the *Tilapia nilotica* is a microphagous omnivore, such aquatic plants as *Hydrilla verticillata, Lemna minor,* and *Chara* sp. could be given as supplemental food under cage culture condition.
2. *Lemna minor* as feed for *T. nilotica* could influence growth-rate of the fish; it gave the best effect compared with the other two aquatic plants.
3. *Lemna minor* gave the lowest water content and the highest protein content in the fish flesh of *T. nilotica; Chara* sp. gave the highest water content and the lowest protein content.
4. Conversion rate of *Lemna minor* was the lowest but it gave the best effect on growth rate at every level of stocking density.
5. The use of aquatic plants as feed for *T. nilotica* could be proposed to be managed as small-scale industry based on cooperative activity of the people in the rural areas where it is possible to carry out the cage culture and where it is easy to culture such aquatic plants as *Lemna minor.*

Edible Crustaceans in the Philippines*



7. Metapenaeus endeavouri **(Schmitt)**
English name: Endeavour prawn.
Philippine dialect: Suaje, Hipon suaje.

Maximum body size is some 15 cm. Rostrum is straight and inclined upwards furnished with 10 to 11 dorsal teeth but no ventral. Telson is furnished with 3 pairs of large lateral movable spines, becoming progressively larger distally.

The whole body is generally yellowish; antenna bright brown; rostrum and abdominal carina dark brown; upropods and telson light brown to yellowsih.

This middle sized shrimp is caught commercially by fish corrals and commercial trawlers mixed with *M. ensis* from shallow water to the depths rounding more than 20 m.

This is originally an endemic species to Australia. At present this is known to exist only in Australia and Philippine waters, although is probably much more widely distributed.

The *M. endeavouri* are sometimes sold at fish market with retail price of P15/kg.

* By H. Motoh; 7th in a series.

Available Technology (*Tilapia*)

(from page 1)

25% respectively; *T. nilotica* and tilapia hybrid (male Nile and female Java) were 20-30% and 30% respectively and (2) several feedstuffs were tested for tilapia and the most promising ones identified.

Technology gaps

A nutritionally adequate ration for tilapia is necessary so that the following should be investigated:

a. Protein-energy ratio

b. Levels of fats and essential fatty acids

c. Vitamin requirements

d. Essential minerals needed

e. Utilization of non-conventional feedstuff

f. Formulation of effective but economical feed

Development of practical feeds for tilapia raised in ponds, cages and other culture units should be attended to.

Some Advances on Tilapia Culture in the Philippines

The research on tilapia conducted at the Brackishwater Aquaculture Center in Leganes, Iloilo and some culture techniques practiced in some parts of the country were reviewed. Culture/hatchery techniques in raising fry to fingerlings were investigated at the BAC with promising results. Separation of sexes before and after spawning improved significantly the production of fry even at salinities greater than 20°/oo. Production of known age fry for sex reversal was also done successfully in batteries of hapas installed in ponds. Artificial sex-reversal has been attained in brackishwater using alphamethyltestosterone at lower salinities.

The use of tenpounder *(Elops hawaiiensis)* or *bid-bid* and tarpon *Megalops cyprinoides)* or *buwan-buwan* as biological controls for tilapia reproduction in a mixed sex population of tilapia increased significantly the production of large tilapia. When tarpon was introduced in milkfish-mixed sexes tilapia populations total production was significantly increased. The ratios of 1:10 (tarpon-tilapia) or 1:6:10 (tarpon-milkfish-tilapia) were found effective in reducing the unsatisfactory-size tilapia in said populations.

Culture of tilapia using ipil-ipil leaves and distillery wastes-ricemill sweeping mixtures as feeds showed encouraging results. The response of tilapia raised in ponds that received piggery wastes has also shown promise. Rice bran and fish meal mixture (1:3:3 ratio) was used as feeds for *T. nilotica* raised in cages at the Freshwater Aquaculture Center and conversion rate of 2.02 was obtained. Tilapia in cages fed with rice bran only yielded 15 tons/cage (20 x 25 x 2.5 m) in 6 units.

A significantly high net production was obtained at FAC by increasing the stocking rate for *T. nilotica* by 100% without additional fertilizer and material inputs.

Technology gaps

The following were identified as necessary for effective culture of tilapia:

a. An effective harvesting method;

b. Refinement of existing technologies for tilapia culture;

c. Culture of *T. nilotica* in brackishwater; and

d. Evaluation of the Fish-Pig (or other livestock) culture in both fish and brackishwater systems

Post Harvest Handling and Processing of Tilapia

Transport and processing technologies for tilapia were reviewed. Wooden boxes, tubs or baskets are the common containers. Ice remains the processing item for transport both for short and long distances.

Processing technologies presented were drying, smoking, fermentation and canning. Unutilized portion of catch could also be made into fish meal.

Technology gaps

There is a need to develop a scaler for tilapia and more processing techniques. The need to test some chemicals that are safe to use to preserve the color of the fish was raised.

Cage Culture of Tilapia in Laguna de Bay

The main problems of cage culture of tilapia in Laguna de Bay are the lack of fingerlings and the need for new cage designs. Cage culture appeared to evolve only as a modification of the pens when fishpen operators suffered losses due to escape of fish.

Two principal tilapia species are raised in cages in this lake, namely; *T. mossambica* and *T. nilotica.* The fingerlings are purchased from Malabon, Rizal and Bulacan *(T. mossambica)* and Calamba, Los Baños, and Bay *(T. nilotica).*

Tilapia production in cages was reported to be 10-15 tons/cage in six months. This level has declined lately for reasons yet unknown.

Technology gaps

The following have been found necessary for a successful cage culture operation:

a. Improved design and construction of cages;

b. Standardization of cage materials that are sturdy, attract less fouling organisms and are not toxic to both fish and consumers; and

c. Proper layout and positioning of cages.

Socio-Economic Study of Tilapia Farming in the Philippines

Based on 1974 operations, 59% of 131 tilapia pond operators from Luzon adopted polyculture (tilapia-carp or tilapia bangos) indicating that tilapia farming is a part-time operation.

Fertilization is not a common practice but where fertilizers were used, chicken manure and carabao dung were applied. Inorganic fertilizers are also used such as urea, 16-20-0 and 14-14-14. Supplemental feeds are given where rice bran, white ant and other feeds were used.

Source of tilapia fry/fingerlings is mostly from BFAR. Stocking size determined the date of harvest.

Average production on a per hectare basis is 209 kg from monoculture. Tilapia-bangos combination could give a total yield of more than 400 kg/ha. Higher yields were obtained from those using fertilizers than from those using supple-

Asian Aquaculture is one *(from page 8*

Readers' letters reveal more than anything else the need for aquaculture information, in general, and information on the work of the SEAFDEC Aquaculture Department, in particular. More people have become aware of the new aquaculture technologies developed and being developed by the Department, of its training program, and of the various information contained in the Department's publications. Suddenly, the Department was besieged by requests for assistance for available publications, schedules of training courses, and even queries on whether a firm in RP can supply a foreign-based company with prawn *(P. monodon)* larvae. One wrote in to ask for inclusion in AA mailing list and to announce that they are looking for agents to sell *Artemia* eggs.

Interest in AA was particularly boosted by other publications which incorporate in their write-ups information contained in AA. Among these are the *Aquaculture Digest* in California, U.S.A., the *Fishing News International* in England, the *Australian Fisheries* and *Farming Today* and *Philippine Farmers' Journal* in the Philippines.

Editors usually keep a "brag file" to keep them going when the lamp is low and the spirit is weak. Here's a sampling:

"Although I receive aquaculture news from several countries throughout the world, your publication is the best. Your articles are concise and to the point. There is no doubt in my mind that the small scale shrimp hatchery is the only way to go. Dr. D. K. Villaluz and Q. F. Miravite should be recognized for giving their support, while M. R. Platon should be complimented on a job well done."

Cornelius R. Mock
Leader, Intensive Culture Systems
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Texas, U.S.A.

"Your issues of the *Asian Aquaculture* which are available at our library, to some extent stimulate the enhancement of aquaculture research among us Asians."

Ms. Rosly Hassan
Fisheries Research Institute
Penang, West Malaysia

"I had an opportunity to read one of the issues of *Asian Aquaculture* in the regional NSDB office. It looks very good. Would you be able to put me on the regular mailing list?

"We are also interested in receiving other bulletins from SEAFDEC to assist us in our course in Aquaculture."

Fr. James A. McKeough, SJ
Xavier University
Cagayan de Oro, Philippines

"I came over a copy of *Asian Aquaculture* and I am impressed of the technical information it contains. This is really what is needed in the field, to remedy the dearth of technical know-how."

Francisco A. Tan, Jr.
Regional Director
Bureau of Fisheries & Aquatic Resources
Quezon City, Philippines

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mental feeds.

In all ponds surveyed, 76% practice pest elimination and 24% don't. The most common method used was "catch and kill" although pesticides were also used.

In general, tilapia farming appeared to be profitable, however only very few farmers are culturing tilapia in commercial scale.

Comparing crude profit estimates from tilapia and bangus production, a marginal profit in favor of tilapia was reportedly realized in one particular case. Acceptability of tilapia as food fish could be gauged from the price of fish and the hectarage devoted to tilapia culture.

Technology Verification Studies

(from page 1)

and, from these information, determined the already available technology that can be put together for field verification studies.

The immediate products were the 45 proposed studies. These were subsequently narrowed down to 12 in discussions among representatives of the Philippines' lead research and development institutions — the fisheries research director of the Philippines Council for Agriculture and Resources Research; the Central Luzon State University college of fisheries dean; a representative of the National Institute of Science and Technology; and the deputy director for training and technology verfication of AIA.

Formulation of the designs and implementation procedures of the 12 study areas is now being done by researchers. Among those involved from SEAFDEC are Wilfredo Yap, head of the Department's mollusc project team; Jurgenne H. Primavera, head of the prawn broodstock (land-based) development project and in-charge of the *Artemia* studies; Rolando Platon, leader of the Barangay (village) Hatchery Project; Dr. Chhorn Lim, a fish nutrition specialist; Dr. J. V. Juario, milkfish program leader, and others.

Meanwhile, leaders and representatives of fishfarmer's associations have been requested to help in the selection of sites for the verification studies. The studies are to be conducted in fishfarmers' ponds.

The results of these verification studies will be put together into a commodity recommendation package similar to the "Philippines Recommends Series" on various agricultural, forestry, and fisheries commodities. They are one-recommendation packages covering the entire range of economic activities (such as from variety selection to marketing) needed to produce and market a commodity that do away with confusing and duplicating recommendations and are based on the latest available research and/or technology verification results.

Technology verification and packaging bridges the gap between the laboratory and the farm. It also takes care of area, situation, location and production-system differences. By being replicated in fishfarms located in different sites or different agro-climatic zones, the verification studies can incorporate specific recommendations for different situations.

Asian Aquaculture is One

This issue makes *Asian Aquaculture* one year old.

Looking back, *Asian Aquaculture,* AA for short, was conceived when the Asian Institute of Aquaculture(AIA) was established on May 23 last year as a unit of the SEAFDEC Aquaculture Department. One of AIA's functions is to bring as quickly as possible aquaculture research results and technology to all those who need them. Specifically, AIA is to be involved in aquaculture development planning, technology verification and packaging, training, and technology dissemination. A lot of communications work, therefore, is imperative for all these functions to be carried out well. Thus, a communications and publications program was instituted and the first communications vehicle to come out was AA.

The first issue of AA came out in July. The great number of people depending on aquaculture as a profession or as a living are greatly in need of information on new developments in the field, especially research results and technological innovations. AA and the few other publications dealing with aquaculture information could not possibly fill the need, especially in Asia. AA is probably the only widely circulated tropical aquaculture-oriented monthly newsletter in the Third World.

AA now reaches some 3,000 individuals and 500 libraries in 84 countries. The subscribers' list includes aquaculture scientists, researchers, academicians, documentation and information agencies, mass media workers, extension agents and fish producers.

The volume of distribution, however, should not be the only basis for saying it is a desirable publication. There has to be favorable feedback from readers. AA has received a good number of them. An average of 10 letters a week ranging from requests for inclusion to requests for publications mentioned in AA, to a few rather ego-lifting congratulatory letters reach the editor's desk.

(Continued on page 7)

The Asian Institute of Aquaculture marked on May 23 its first full year of operation with a one-day open house which featured an exhibit, display and distribution of the various extension-oriented publications it has been producing, and a series of audio-visual presentations on the R & D accomplishments and thrusts of the SEAFDEC Aquaculture Department. The open house was ushered in by the cutting of the ceremonial ribbon by Mrs. D. K. Villaluz (rt) assisted by l-r) Drs. Q. F. Miravite, Noboru Hoshino, deputy chief of the Department, J. C. Madamba, AIA director, and Dean D. K. Villaluz, department chief.

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