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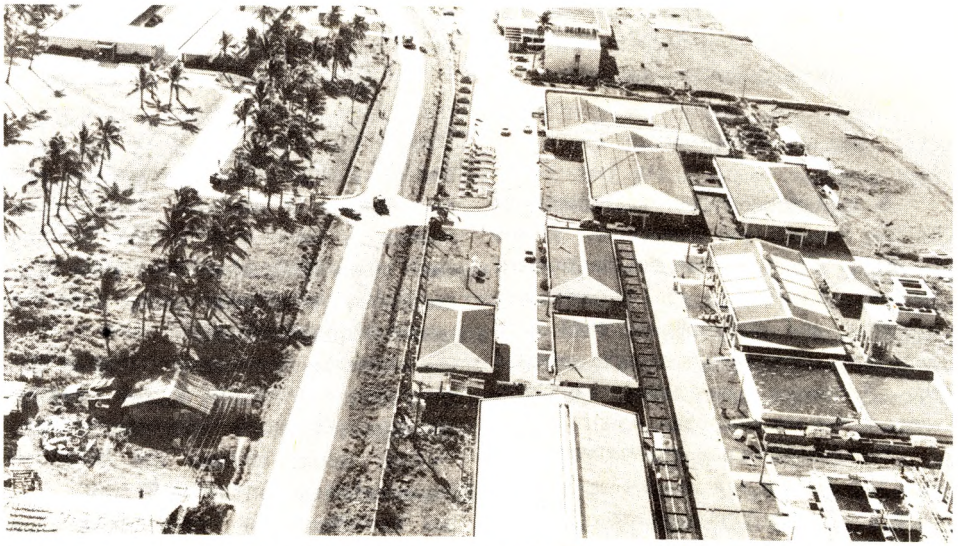
Challenges for Aquaculture Research in Southeast Asia

Fish has a long way to go from the laboratory petri dish to Southeast Asia's frying pans. But if aquaculture scientists of the region have their way, they would in 20 years' time get those pans constantly sizzling with fish, cultured fish to be precise.

The region's fishery experts and policy makers agree that aquaculture — the culture of finfish, shellfish and crustaceans — will have to make up for the predicted slack in the production of capture fisheries which accounts for almost **9 out of 10 kg fish produced in the region.** The decreasing rate in fish catch is even now being felt by countries with modern deep sea fishing facilities like Thailand and Japan, and by the thousands of small fishermen casting for smaller fish along the coasts of the Philippines, Indonesia and Malaysia. Primary culprits for the decelerating sea catch are overfishing, pollution, steep fuel costs, and, for countries whose powerful fleets used to foray in foreign waters, the new regime of the seas.

Abetted by the projected doubling of Southeast Asia's population now estimated at 218 million, a stiff order has indeed been placed on the aquaculture industry to supply the region's fish need in the year 2000 — some 15.26 million metric tons a year. This is based on a doubled population (or 436 million) and a per capita fish consumption of 35 kilograms. Among themselves the Southeast Asian countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) are now producing some 5.05 million MT of which only 11 percent or about 556 thousand MT is aquaculture's share. While experts see a five-fold increase in aquaculture production — roughly 2.7 million MT — in two decades, the region would still be short by almost 7 million MT, assuming that yield from capture fisheries does not anymore increase. It will increase, of course, but at a decelerating rate. And aquaculture will have to fill the ever widening gap between fish demand and production.



The research complex of the SEAFDEC Aquaculture Department at the coastal town of Tigbauan, Iloilo province in Panay Island, Philippines. A difficult task has been placed on the aquaculture industry of Southeast Asia to increasingly fill the slack in the region's fish supply resulting from decelerating production in capture fisheries. Twenty years from now, the region's fish need will be a staggering 15.26 million MT a year.

How?

The easy path is obviously area expansion. Among the Southeast Asian countries, Indonesia has the vastest brackishwater area that remains undeveloped for fish culture. And the coastal waters around the Philippines, Malaysia, Thailand and even Singapore can be profitably tapped for mariculture, the farming of fish in shallow coastal areas. Mariculturists in fact are now saying that this type of fish farming will eventually become the significant provider of cultured fish and shellfish. Freshwater

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Challenges for aquaculture . . .

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aquaculture has a potential area of 5 million hectares in the region but only 213 thousand hectares (4 percent) of this resource is being farmed. Experts however see a limited (10 to 15 percent of the potential) expansion in freshwater fish culture. Brackishwater farming, on the other hand, has been predicted to expand to about 30 percent of present potential with most of the areas that will be opened to be farmed for shrimps, a high-priced dollar earner as well as an attractive cash crop.

The second approach to increased production and which scientists are devoting most of their efforts to is intensive fish farming. This will be the cause of higher production in brackishwater and mainly of milkfish, experts say. Among SEA countries, however, milkfish is grown in great commercial quantities only in Indonesia and the Philippines.

Prospects

In a meeting convened late last year by the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC), the Department's scientific and technological staff with help from other agency experts prepared the following aquaculture industry scenario for the Southeast Asian Region:

For *brackishwater aquaculture*, milkfish and prawns will remain as the two most important species; the trend will be from monoculture of milkfish to its polyculture with prawn while there will be a corresponding increase in the monoculture of prawns to about a third of the total area.

Intensified production systems will be evolved through the development of feeds, deep ponds and circulating system, and with better control measures for pests, predators and parasites.

There will also be a significant increase in organic fertilizer use owing to the high cost of oil-based inorganics.

Experts eye the development of at least 5 percent of all the available swamplands in the region even as they predict a jump in the average production of milkfish in brackishwater ponds to 1,500 kg per hectare a year with the upper range "reaching as high as three tons among intensive systems."

Scientists also warn of the danger of pollution. Fry grounds for milkfish and prawns will be seriously affected by water pollution, they said. On the other hand, they sounded a bright note with the prediction that shortages in fry and fingerlings will considerably ease up with the refinements of hatchery, breeding and handling techniques. There will be a shift to develop hatchery techniques for other culture finfishes as culture systems are developed, they said. Specialized prawn hatchery-nursery operations will increasingly emerge.

With prawns, they have fearlessly forecast a national (Philippines) average production of 3000 kilograms a hectare a year in earthen ponds with supplemental feeding. Asian exports of shrimps to developed countries will increasingly consist of cultured prawns, they said.

In general, experts see an increase in technology transfer efforts among countries in the region but think that more and more large private corporations will be engaging in intensive brackishwater culture, a trend that is now showing itself in the Philippines where a few large companies have been going into the prawn farming business.

However, they are looking at the possibility of smaller farm holdings banding themselves into cooperatives, "which would increase the need for improved extension services."

In *freshwater aquaculture,* the scientists predict a five-fold increase, which is in line with the global and regional trend; a 10 to 15 percent expansion in area; and an increase in the yield per unit area of 3 to 4 times present levels.

It is in *mariculture* that the experts see the greatest prospect for expansion of aquaculture after the inland and brackishwater areas have been exploited. Its contribution will be increasing until it accounts for a substantial share of the total aquaculture yield, they hinted.

Molluscs (mussels, oysters and cockles) will be the major mariculture species and will ultimately constitute three-fourths of the mariculture production. The development of mollusc culture however will be initially inhibited by seed collection and marketing constraints.

The production of herbivorous finfishes in enclosed coves and lagoons will depend on the identification of suitable sites and selection of species while high-valued species with good export potentials will be cultured in cages. They also see an expansion of the production systems in seaweeds.

Mariculture will take care of replenishing the sea stock, as it is being done now in Japan. The large scale breeding of some marine species may be achieved in 10 to 15 years, they said. The young will be released in selected areas to replenish wild stocks.

Finally, the scientists unanimously think that mariculture will have to be the main alternative source of employment and income for subsistence offshore fishermen. This has been demonstrated by the family cage culture system developed in Malaysia.

A lingering look at these research and technological development challenges in aquaculture from now to the year 2000 gives one the feeling that the scientific sector has a great deal of catching up to do. And, if we may use a biblical allegory, aquaculturists may have to do just as well in the next twenty years as the One who fed the multitude after His sermon on the Mount.

Aquaculture fisheries . . .

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grow natural feeds; and

4. "Bangus" and "sugpo" could be cultured together without problem. Thus, higher yield per area of pond could be expected.

The Aquaculture Department of the Southeast Asian Fisheries Development Center has been conducting research on seed production and cultivation of some valuable marine species: "Bangus" *(Chanos chanos),* Sugpo *(Penaeus monodon),* "Ulang" *(Macrobrachium rosenbergii),* Alimango" *(Scylla serrata),* "Alimasag" *(Portunus pelagicus),* "Tahong" *(Perna viridis),* "Lampirong" *(Placuna placenta),* oyster, seaweeds and other species of high economic value.

Population growth is increasing at a fast rate. Scientists believe that the animal protein requirements of the increasing population can only be supported by the sea. ●

Mindanao farmers train in aquaculture

The mobile training program of SEAFDEC and the Bureau of Fisheries and Aquatic Resources closed out the year with back-to-back training courses for fishfarmers in two areas in the Mindanao region. Beneficiaries: 42 in northeastern Mindanao, composed mainly of members of the Butuan City and Agusan del Norte Fish Producers Association and 56 in southeastern Mindanao all coming from the vast Davao and Cotabato provinces.

The Mindanao training programs turned the mobile training wheel into full cycle. Started in 1978 for fishfarmers of Zamboanga in southwestern Mindanao, the mobile program of the Aquaculture Department and the Philippines bureau of fisheries has covered the entire length of the archipelago. Last year, the program was held for farmers of Eastern, Central and Western Visayas as well as the southern tip of Luzon. Earlier this year, the program was held in the northeastern and northwestern regions of the island of Luzon. Trainings are held in suitable places in the regions.

Focus of the program is on milkfish and prawn culture in ponds. The topics cover such essential phases of aquaculture production as hatchery operations, pond construction, development and operations, nutrition, disease and predator control, prawn biology and broodstock development, and nursery and grow-out pond operations.

In these two sessions, the fish producers group of the regions requested training for their members. The Butuan and Agusan association shouldered all the expenses for the participants, local costs as well as the accomodations expenses for the training team composed of trainors and researchers of the SEAFDEC Aquaculture Department. The fisheries bureau and the associations also provided the logistical support and the training sites. In both venues, each participant contributed an amount to defray local expenses.

The mobile training scorecard for 1979: 399 participants from 4 regions ●

Fishfarmer trainees visit one of their colleaque's newly built pond at Butuan City in Northeastern Mindanao, Philippines. Back to back on-site farmers' milkfish and prawn culture training courses held in the Mindanao region for 98 fishfarmers closed out the 1979 SEAFDEC Aquaculture Department training programs.

613 Train at SEAFDEC Aquaculture Department in 1979

More than 600 fishfarmers, private operators, technicians, government workers and technologists from a dozen countries of the third world attended various courses conducted by the Institute of Aquaculture of the SEAFDEC Aquaculture Department last year.

Five international programs — aquaculture research methodology, aquaculture management for milkfish, aquaculture management for prawn, aquaculture engineering, and management and operation of small-scale prawn hatchery — turned out 116 successful trainees mostly coming from the Southeast Asian countries of Malaysia, Singapore, Thailand, Indonesia, and the Philippines but with a significant number of fisheries technologists from Nigeria and Cuba and at least one each from Panama, Colombia, and Brunei.

The special skills training courses which were offered to fulfill linkage agreements and requests of assisting agencies were attended by 33 participants, 10 from the Indian Council for Agricultural Research, 3 IDRC-sponsored trainees coming from Sarawak, Egypt and Sierra Leone and 20 from Cuba. The special courses included prawn culture, mass production of fishfood organisms, milkfish breeding, cage and pen culture, milkfish culture, freshwater aquaculture engineering and management.

On the local level, around 65 Filipino technicians and private pond operators attended the barangay (village) hatchery operations course and two prawn culture training sessions.

Finally, four mobile training courses held in four separate Philippine regions brought the latest in milkfish and prawn culture technologies to 399 fish farmers, pond technicians, and production workers. ●

Integrated Crop-Livestock-Fish Farming in the Philippines*

Much of the integrated farming systems being practised in the Philippines have been largely evolved by the private sector; the more advanced segments have adapted or modified some foreign technologies. Following are some existing practices and on-going research in this field as gathered from available literature and observations.

I. Small-scale Operations

A. Crop-Based Farming Systems

1. Rice-Fish

The old practice of trapping wild fish inside rice paddies has been developed into an economically feasible technology by the Freshwater Aquaculture Center of Central Luzon State University.

The irrigated rice paddy is provided with a center trench running lengthwise which serves as fish refuge, passageway and catch basin; the dikes are made slightly higher than in rice monoculture; and a gate on the dike is constructed for water entry and drainage. A wire screen is installed in the gate to prevent entry of predatory fishes and escape of fish.

The insect-resistant, high-yielding IRRI rice varieties are used which have a culture period of 110 to 145 days. The recommended fish species are *Tilapia mossambica, T. nilotica* stocked at 3000-4000/ha and *Cyprinus carpio* (common carp) at 3000-4000/ha. In polyculture, stocking rates are 4000 tilapia and 2000 carp/ha. Culture period for the fish is 80-100 days in rice-fish culture. Experiments so far indicate that use of carbofuran pesticide is not toxic to fish; no residue is left in the fish.

Results from 19 field trials in 1977-1978 yielded an average, on a hectare basis, of 116 cavans of palay (50 kg/cavan) and 204 kg of fish per cropping. This corresponds to a mean net income of about P5,210, more than that from rice culture alone by P677. The culture method is now undergoing a nationwide pilot implementation phase. Some rice farms outside the pilot areas are adopting the technology.

A major constraint to widespread adoption, however, is shortage of fish seed supply. For the 1.4 million hectares of irrigated ricelands alone, not counting the needs of fish cages and ponds, the fingerling requirement would be 4,200 to 8,400 million per cropping. Since the combined output of all hatcheries in the country cannot supply this, the rice-fish program includes the training of farmer-cooperators on fish hatchery management.

Also being tried is the scheme of alternate rice and fish cropping in the same field to reduce pesticide hazard. At the CLSU College of Inland Fisheries, experiments are being done on the culture of freshwater mussel, shrimps and snails in paddies with and without rice.

2. Rice-Vegetable-Fish

A one-hectare farm in Nueva Ecija province produces rice, vegetables and fish. The setup includes: (1) tilapia breeding and nursery ponds of approximately 1,000 sq m; (2) rice-fish paddies of about 9,000 sq m; (3) slightly raised and widened (1.5 to 2 m) paddy dikes occupying a combined area of 1,000 sq m; and (4) an independent and reliable water supply with underground channels running along the dikes to the point of delivery.

The dikes are planted to vegetables such as eggplant, pechay, native onion, tomatoes and beans, as well as some citrus and banana plants. Taro plants locally known as "gabi" are found along the base of the paddy dikes, but rice is still the major crop.

The farmer, Francisco Carbonel, invested P12,000 for this project which has reportedly increased his farm gross income from P10,000 to P25,000 a year.

A similar one-hectare farm was put up in 1977 at the Central Luzon State University for economic feasibility studies and demonstration purposes. The so-called "Farm of the Future" consists of four tilapia nursery and breeding ponds, 698 sq m total area; five rice-fish paddy fields, 8,779 sq m total area; several elevated 3-4 m wide dikes for vegetable beds, 2,446 sq m total area; an underground channel along the main dike for distributing irrigation water; a pump house; and a farm house made of bricks.

The total development cost amounted to P57,479, including the cost of the farm house of about P11,700. The farm reportedly produces rice, *Tilapia zillii,* and 15 other crops for a net income of P11,656 in one year.

3. Fruit-Vegetable-Pig-Poultry-Fish

Several multi-commodity combinations are probably practised by the more enterprising farmers in the country, but few are documented.

*From the paper, "The Philippine Experience in Integrated Crop-Livestock-Fish Farming Systems, presented at the Symposim Workshop on Agribusiness Systems for Integrated Crop-Livestock Fish Farming, 19-25 November 1979, Los Baños, Laguna, Philippines, by Dr. Elvira Tan, director of the Fisheries Research Division, Philippines Council for Agriculture and Resources Research.

One such case is that of a 1.6-hectare farm in Sta. Barbara, Pangasinan. It consists of a fruit orchard, vegetable garden, piggery, poultry, and fishpond. The manure from 16 sows and 1,600 broilers are fed into a digester for biogas production. The resulting liquid sludge, known to be a better fertilizer than fresh manure, is used to fertilize the orchard, vegetable garden, and fishpond. The entrails of dressed chicken from the farm, together with chopped banana stalks and vegetable scraps are cooked in biogas-fired stoves to feed the pigs. Biogas is also used for various domestic purposes.

Since 1970, when waste recycling through biogas operations became popular, a number of rice-vegetable farms with backyard piggeries have been using the effluents from the digester to fertilize fields and small fishponds.

4. Crop-Livestock

Livestock is produced in commercial ranches or in backyards. Because of overstocking or overutilization of current pasture areas, researchers are focusing on the improvement of native grasslands by oversowing them with legumes or by establishing pure grass and grass/legume pastures with fertilization. With small feedlots, integration with crop farms is favored since the animals subsist mainly on weeds, crop residues and farm by-products.

In 1978, there were 4.23 million heads of cattle and carabao in the country's backyards, much more than the total ranch animal population of 495,620. Still a lot of feed resources are unutilized, considering that an animal population of 11 million can be potentially supported by feed materials coming from the country's crop area of 7.93 million hectares planted to rice, corn, sugarcane and coconut. One probable reason given by livestock researchers is most crop fields and livestock feedlots

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Edible Crustaceans in the Philippines*

14. VERUNA LITTERATA (FABRICIUS)

English name: Shore crab

Philippine name: Talangka (Tagalog), Calampay (Ilongo), Katang (Ilongo), or Kalampay (Cebuano).

The larger specimen attains about 5 cm in carapace length. The carapace is flattish and its frontal margin horizontal. Propodus and dactylus of ambulatory legs are flattened and modified for swimming. Chelipeds are usually asymmetrical.

The ground color of the entire body is brown with numerous blackish spots.

They are sometimes found clinging to floating timber, bamboo and coconut shell, but usually inhabit mangrove creeks, freshwater canals, brackish fishponds or even rice fields. The swarming of megalopa (one of the larval stages) is from time to time observed going upstream through a small river mouth.

This small-sized crab is mainly caught with baby trawlers or fish corrals at the mouth of the bay.

This species is distributed from Japan to India, Madagascar, and the East Coast of Africa. Regardless of big catch, it has little commercial value because of its small size.

In rural areas the market price is about P5/kg.

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*by H. Motoh; 14th in a series

Erratum: Mr. Motoh's description of *Portunus pelagicus* in the preceding issue was the 13th not 12th in the series.

Integrated crop-livestock . . .

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are located in separate places.

Thus, for backyard livestock production, a major research thrust is the integration of fodder production with existing cropping systems. A model for an upland farming system based on ipil-ipil *(Leucaena* sp.*)* grown in hedge rows with corn or sorghum in between has shown good potentials for cattle fattening and leaf meal production.

5. Coconut-Pasture-Cattle

Instead of growing crops under coconuts, some farmers raise livestock to free the soil surface of weeds. This way they save on weed control at the same time "convert" the weeds into meat or milk. About 400,000 hectares of the 2.5 million hectare area under coconuts are currently used for grazing.

To improve the pasture, native grasses are replaced by high-yielding grasses and legumes.

As in other integrated systems, however, more research is needed here to obtain the right balance of farm components.

B. Livestock-Based Farming Systems

1. Pig-Crops-Fish

Increased interest in animal waste recycling for biogas production has given rise to livestock-based integrated farming systems. This has also improved the operation of existing ones. Basically, the sludge from the biogas plant is used as fertilizer for crops and fishponds. Following are examples of predominantly pig-based small-scale operations.

The University of the Philippines at Los Banos has designed a model recycling system that produces algae, pork, biogas, rice, vegetables and fish. Hog manure and washings are channeled into the digester and the effluent used as fertilizer for the rice and vegetable fields and the tilapia and chlorella ponds. Chlorella, a high-protein alga, serves as substitute for soybean oil meal in pig rations, as feed for the fish, and fertilizer for vegetables.

Channeling the sludge from the digester to an algae pond is also done in the swine breeding station of the Bureau of Animal Industry (BAI) in Tarlac province. The liquid from the pond fertilizes a fishpond and a field planted to Napier grass.

Two integrated farms operated by Jose Sanvictores use entirely hog manure as fertilizer. One of these farms does not have to use chemical fertilizers for the ricefields. In the other farm, the liquid manure is pumped to the Napier and Para grass fields, the runoff goes to a water chestnut plantation, and the overflow to a backyard catfish pond.

2. Pig-Poultry-Cattle-Vegetable

The uses of waste recycling are also evident in the Golden Farm in Sta. Maria, Bulacan province, where vegetables are grown in addition to livestock and poultry production. The methane gas produced from hog manure and pen washings is used as fuel for drying chicken droppings to be fed to the cattle; the recovered solid sludge from the digester, as feed material for the pigs; and the liquid sludge, as fertilizer for squash, bitter melon and citrus plants.

C. Fish-Based Farming Systems

1. Fish-Pig

The integration of animal husbandry with aquaculture has been reported in many countries in Asia and Central Europe. In the Philippines, such combination is not extensively practised. Of the few fishfarms that raise pigs to provide manure for pond fertilization, the biggest perhaps is the Jamandre farm found in Iloilo province. (This is described in the latter part of the article.)

Preliminary results on fish-pig production at the Freshwater Aquaculture Center indicate that fish yields of 5,850 kg/ha in 270 days could be obtained, representing more than 4 times the production of raising fish alone at the same fish density with inorganic fertilization only. The combination used was 60 pigs and 20,000 fish/ha, composed of 17,000 *Tilapia nilotica,* 2,800 *Cyprinus carpio* (common carp) and 200 *Ophicephalus striatus* (mudfish or snakehead). Mudfish was added as a tilapia predator to control reproduction.

In another experiment, brackishwater ponds rearing 4,000 milkfish and 2,000 tilapia per hectare in polyculture are supplied directly with pig wastes washed from pens over the ponds. The system produced an average of 252 kg of milkfish and 180 kg of tilapia after 120 days.

2. Fish-Chicken or Duck

Fish-chicken or duck combinations are not as widely practised, if at all, in the Philippines as in other Asian countries. Chicken manure, however, is purchased and applied in brackishwater milkfish ponds in the country at an average rate of one ton/ha; the recommended rate of application is 2 tons/ha.

Based on a 1974 survey of 1,394 pond operators, 19% used organic fertilizer sources; 26% organic-inorganic fertilizer combination; and 54%, inorganic. Of the organic sources, chicken manure is the most widely used, followed by hog manure, guano and compost. A 1979 survey found that 42% of fully developed milkfish ponds sampled had less than 4% organic matter. Pond soils, experts say, should have at least 9 % organic matter to obtain abundant algae growth for fish food.

Fish-duck integration is being tried also at the FAC. Initial tests indicate maximum stocking rates of 750 Peking ducks and 20,000 fish/ha with the same fish composition used in the fish-pig experiment earlier mentioned. With this combination, the maximum net fish yield after ducks have become regular layers would be 5,070 kg/ha in 270 days.

3. Fish-Taro

Experiments are underway at the CLSU using rice paddies as shallow fishponds for simultaneously growing tilapia and taro *(Colocasia esculenta).* One setup has elevated plots for the plants and trenches for the fish. Another system has the whole pond planted to taro at a spacing similar to rice culture.

II. Large-scale Operations

A. Pig-Rice-Corn-Vegetable-Fish

Maramba (1978) describes the operation of Maya Farms, the agro-industrial division of Liberty Flour Mills, Inc., in the book, "Biogas and Waste Recycling." The 24-hectare farm complex in Anti-

polo, Rizal province integrates hog raising with slaughtering, meat processing and canning, as well as feed mixing and crop and fish production.

The biogas works eliminate the odor of manure from 10,000 pigs. Biogas is used for cooking at the canning plants, heating the scalding tanks in the slaughterhouse and cooking vats in the meat processing plant, running gas refrigerators, water heaters, deepwell pumps, and other equipment.

Scraps and wastes from the slaughterhouse, meat processing and canning plants are turned into meat meal, bone meal and blood meal — ingredients of hog feeds.

Sludge conditioning takes place in settling basins and lagoons; the settled solids are recovered, dried and processed into feed materials. A waterwheel driven by a windmill helps aerate the remaining liquid sludge in a series of lagoons to remove toxic substances and produce better fertilizer.

Irrigation water from the lagoons fertilizes sweet corn and vegetables that are canned. During rainy seasons, rice is grown instead of vegetables. The liquid fertilizer and feed sweepings from the pig pens also induce plankton growth in fishponds which yield in 3 months about 2 tons of tilapia per hectare.

The total waste recycling system costs more than P750,000 to develop.

B. Fish-Pig-Cattle-Coconut

Ernesto V. Jamandre of Iloilo province has a piggery in his 120-hectare milkfish pond. Before that, the newly-constructed brackishwater ponds initially gave low yields; when he later applied raw sewage from the pig pens, the pond soil reportedly improved and the fish yields gradually increased. He also grows shrimps and tilapia.

Two piggery units are found in the farm. One unit supplies clear water effluent from a digester to the nursery ponds. The other has a four-compartment treatment tank added to the digester. The sludge from the last compartment can be directed through plastic hoses to six grow-out ponds.

In 1977, Jamandre reported a total pig stock of around 1,200 including 134 sows and 8 boars.

The farm also includes about 35 heads of cattle which graze on the 6-meter wide principal dikes and on the 16 hectares of grass area under coconut trees adjoining the fishponds. ●

Aquaculture fisheries . . .

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Step. 1. Artificial seed production

The mother prawns used for spawning are usually big weighing over 50 grams on the average. The larvae hatched out are reared artificially up to stocking size or 20 mm body length for about 30 days. Presently, we can produce two hundred million fry of the above-mentioned size a year. On the average one hundred thousand fry or an equivalent of 30 percent survival rate from nauplii to fry stage may be produced from one spawner. On the other hand, under natural conditions, only a small percentage of larvae survive. Thus I think the effect of artificial rearing is tremendous. We usually use 200 to 500-ton concrete tanks in the hatchery.

Step 2. Rearing in nursery pond

Due to very small size, fry from the hatchery are not directly released into the sea but are first reared in nursery ponds. This is to train them to escape from enemies, to search for food and to acclimatize them to their natural habitat in the sea. It is, in short, a training for survival. Usually we keep the fry in the nursery situated in shallow coastal waters surrounded with artificial dikes for one or two weeks.

Step. 3. Release of fry into the sea

Generally, prawns are nocturnal in habit and are usually observed to inhabit shallow coastal waters to escape from big predators. Thus, in Japan, fry are released in the sea during night time or during the lowest tide. Furthermore, fishermen are asked to refrain from catching the newly released young prawns until they reach marketable size.

Step 4. Recapture

After about six months the released prawns reach marketable size of about 15 cm in body length. Some of them migrate to spawning grounds. It would be considered a success if fishermen could catch at least 3 percent of the total number of fry stocked.

Regarding Aquaculture Fisheries in the Philippines, pond culture fishery has a brighter future for development in this country than in Japan for the following reasons:

1. The fish being reared in Philippine ponds attain a higher growth rate because water temperature is continuously high, from 25°C to 35° so that fish and prawns could be cultured throughout the year;

2. There is less pollution of coastal waters by industrial plants and sewage disposal;

3. There are vast areas of undeveloped mangrove swamps and estuaries in various parts of the country. Also, cost of developing potential pond areas is much cheaper here than in Japan;

4. Observations show that the spawning seasons of useful species are longer in the Philippines than in the temperate zones, thus more fry could be produced for a longer period;

5. Water management in ponds can be easily done due to a wide range between low and high tides. In this case, competitors and predators of cultured fish or prawns could easily be handled;

6. "Lab-lab", which is a microbenthic complex of diatoms and zooplankton grows naturally in nursery and culture ponds and serves as a cheap supply of feeds for "bangus" (milkfish) and other species; and

7. The price of sea foods is high and the demand is great. In connection with these observations, I am suggesting that artificial seed production techniques best suited for tropical and sub-tropical conditions be studied and established in order to fully develop the fish pond industry.

Further, "bangus" culture and "sugpo' *(P. monodon)* culture should be given priorities due to the following reasons:

1. Both species have high market value and are in great demand;

2. Both grow rapidly in ponds the whole year round;

3. "Bangus" are generally herbivorous, specifically plankton feeders. Thus, pond owners could simply apply both organic and inorganic fertilizers in their ponds to

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Aquaculture Fisheries in Japan and the Philippines – A Comparison

In Japan, the two most popular aquaculture methods are pond culture and marine culture.

In pond culture, fry obtained from the hatcheries by artificial propagation techniques or from natural sources are reared in culture ponds up to marketable size. The culture of yellowtail and red sea breams are good examples. On the other hand artificially bred in the marine culture method, millions of fry in hatcheries are released into the sea where they grow to maturity under natural conditions instead of stocking them in culture ponds. The marine culture method combines artificial and natural methods and is sometimes called "Farming Fishery." In pond culture the products belong to the pond owners only. Marine culture method makes use of the sea for rearing, hence, the products belong to everybody.

The pond culture method is not as popular in Japan as it is here in the Philippines. This is due to the scarcity of cultivable pond areas. In fact, we usually make use of existing salt beds and convert them into culture ponds.

Realizing the limitations of the pond culture method, marine culture was developed by the Japanese more than 15 years ago to help meet the demands for marine products and to replenish declining populations of marine resources in natural waters. Over-exploitation and industrial pollution of fishing and spawning grounds have largely contributed to the decline. To effectively replenish the stock in the sea, we have to secure millions of fry for stocking. About two decades ago, the quantity of fry needed for stocking could not be produced artificially. Thus, during that time, pond culture and marine culture fisheries depended mainly upon natural sources. After a few years, however, mass seed production technique of "Kuruma ebi" *(Penaeus japonicus* Bate) was established by the Seto Inland Sea Fish Farming Association researchers under the leadership of Dr. Motosaku Fujinaga. As a result of the pioneering work of Dr. Fujinaga on "Kuruma ebi" artificial propagation techniques of other species – such as other shrimps, crab, abalone, flatfish and rockfish – were studied and developed. The results of the research at fisheries universities and in laboratories supported by the Japanese government were disseminated to prefectural fisheries experimental stations and to fisheries cooperatives located throughout Japan. At present we have the capability to annually produce two hundred million fry of "Kuruma ebi" and several million fry of other edible shrimps, crab, abalone, rock fish, and others.

Which is more profitable for fishermen, pond culture or marine culture? If we apply modern techniques in artificial propagation on a large scale and use cheap, unpolluted and large pond areas, the pond culture system would be more manageable than the natural sea and predators and competitors can be easily exterminated. In the case of the marine culture method, most of the fry released into the sea are at the mercy of predators. It is a pity however, that at present there is no sound evaluation on the effects of restocking. In spite of this situation, the fishermen are forced to release their fry into the open sea due to Japan's geographical limitations and also due to pollution of shallow coastal areas.

The following are the steps taken in the marine culture methods: (This is in the case of "Kuruma ebi" *P. japonicus).*

(Continued on page 7)

* **Contributed by H. Motoh, Ecology Project Leader**

CONFERENCE ON THE GIANT PRAWN

The Department of Fisheries of the Royal Thai Government has announced the holding of an international conference on *Macrobrachium* farming from June 15 to 21 in Bangkok, Thailand.

The symposium aims to bring farmers, businessmen and scientists together to share their experience in farming *Macrobrachium spp.* and in related research and developmental work through the presentation of papers, discussion and field visits.

Co-sponsors are the International Foundation for Science, the South China Sea Programme, and the FAO Regional Office for the Far East.

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