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SEAFDEC "Better life through aquaculture"

AFLATOXIN DANGER EXPLAINED

News item AFLATOXIN IN PRAWN FEEDS MAY BE CAUSING DISEASES IN PRAWNS appeared in **Business World** 18 October 1988. It is reproduced below verbatim and a rejoinder follows because the topic is of serious concern.

The News. "With so much attention focused on aflatoxin in copra, a scientist reveals that few are aware the same substance could possibly be found in prawn feeds."

"Biotechnologist Apolinario D. Nazarea told **Business World** that the aflatoxin in prawn feeds could be the reason the prawns farmed locally are hit by various diseases and stunted in growth."

"He said the aflatoxin in prawn feeds may be traced to the fishmeal imported by feed processors/producers."

"Tons of fishmeal, he said, are merely shipped on vessels without protection from any weather disturbance. Thus, when it rains, the fishmeal gets wet and breeds mold caused by a fungus called **Aspergillus flavus** and **Aspergillus Parasiticus.** This, he explained produces the aflatoxin."

"While the feed processors/producers may argue that they dry the fishmeal to kill the fungus before integrating it with the other feed components, Dr. Nazarea contends that the aflatoxin remains in the fishmeal."

"He theorized that this could be the reason the prawn industry has recently been hit by a spate of diseases, increasing the mortality of prawns and their fry."

"The prawn and fries have succumbed to a number of diseases such as the blue shrimp disease, so called because of the bluish cast of the prawn's shell once it is infected with water bacteria, **vibrio harveyi,** also called the luminous bacteria because it is brilliant like a firefly in the dark; and other diseases due to bacteria like **psuodomonas (sic)** and **aeromonas (sic).**"

"The country's attention focused on aflatoxin after the European Community began imposing standard limits on its copra imports."

"Scientists have provided evidence indicating that humans may eventually contract cancer, especially from drinking milk produced by cows fed with aflatoxin-infected copra meal. - SFA."

The Rejoinder. **Business World** claims that it was **told** of the issue by Dr. A.D. Nazarea. This is doubtful. More correctly, Dr. Nazarea was hypothesizing. In fairness to him, "SFA", not his initials, appears in the credit by-line.

Regardless, the issue raised is valid: aflatoxin is a harmful substance, a potent carcinogen. But the presentation is one-sided, patently alarmist. Rather inform, it evokes undue public alarm. And worse, it may set back farther the local aquaculture industry still reeling from the impact of the last toxic red tide. The indictment of fishmeal extends not just to prawn but to milkfish as well, to tilapia, to carp, to siganid, to lobster. Too, fishmeal, as "trash fish" in bulk, goes into the making of fish sauce (**patis**) and fish syrup (**bagoong**).

Aflatoxin is a generic for mycotoxins produced primarily by **Aspergillus flavus** and **A. parasiticus**, both filamentous molds. **Aspergillus flavus** is omnipresent in the environment (**A. parasiticus** is not known to occur in the Philippines); its spores are dispersed and disseminated in the air we breathe. Like most fungi, it grows on virtually all kinds of organic substance with the proper balance of carbon and nitrogen (C/N). Animal matter has low C/N, hence is unlikely to support profuse growth of molds including aflatoxin producers.

Fishmeal **is** animal matter. When it gets wet as in the scenario in the news item, it will undergo putrefaction. Worms and insect maggots, **not** the molds, will get to it first. And if present in the meal, molds, including the aflatoxin variety, will not stand a chance; they too will be devoured!

Aflatoxin contamination is a far more serious concern in post-harvest handling and storage of agricultural crops such as corn, peanut, copra, sorghum, other cereals, seed beans, tubers. Indeed the aflatoxin episode began when moldy peanut meal from Brazil got incorporated in feeds and caused widespread death of turkey and livestock in Great Britain in 1960. Feed ingredients of plant origin, unlike fishmeal, are predisposed to mold infestation and aflatoxin contamination. Corn meal, peanut meal, soybean meal, potato and cassava flour, rice bran, and others as protein-carbohydrate source or filler-binder are excellent substrates for growth of **A. flavus.** These components may contain aflatoxin unless proper handling and post-harvest management is practiced from the source (farm) to the mill, to the feed plant. Feed processors are aware of the problem and already have taken appropriate measures, e.g., reduction of feed moisture content to 10%, and use of protective plastic undercoat in 50-kg feed bags. It is probable the risk of contaminating feeds with aflatoxin is greater with the end-users, especially when feeds are purchased in bulk, apportioned, and then stored improperly in warm and humid conditions.

Weather conditions in the Philippines and elsewhere in the humid tropics are such that aflatoxicosis therein is a distinct possibility; indeed, the problem is referred to in some extension publication, and at SEAFDEC **A. flavus**, but as yet not the toxin, has been found in some commercial prawn feeds (M. de la Cruz, pers. comm.). Yet there is in the country no documented case of aflatoxicosis in either cultured or wild shellfish (prawns included) and finfish.

Recognition of the disease when it occurs is itself a problem. At SEAFDEC, adult prawns exhibit yellow then red discoloration of the shell when aflatoxin B_1 (at least 50 ug/g feed) is added in the diet (M. de la Cruz, pers. comm.). But it remains to be proved if this finding relates to reddening observed in prawns cultured locally and also to the "red disease" (**Penaeus monodon, P. penecillatus**) reported in Taiwan and suspected to be due to intake of rancid feed. In Mexico, aflatoxicosis-afflicted prawns (**P. vannamei, P. stylirostris**) show no reddening of shell but as in the SEAFDEC study with **P. monodon**, the hepatopancreas is blackish.

The "blue disease" (**P. monodon**) in Tahiti is suspected to be caused by a virus. Contrary to the claim in **Business World**, there is no evidence of any link to aflatoxin, much less to the bacterium **Vibrio harveyi.**

Luminous vibriosis (**P. monodon**) is the one associated with **V. harveyi** (C.L. Pitogo, pers. comm.) and it causes mass mortality of larvae in hatcheries. This plague has nothing to do with aflatoxin-contaminated feed formulations. Feeding in hatcheries is often only with live algae (diatoms, **Chlorella**) and brine shrimp (**Artemia**).

The bacterial groups **Pseudomonas** and **Aeromonas** have been implicated in a number of primary and secondary disease syndromes in penaeid prawns. Again, there is no evidence such abnormalities are related to feeding with aflatoxin-contaminated diet.

Source: **Rejoinder** by I.J. Dogma, Jr., Researcher, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, 11 November 1988.

FISH HEALTH: WHAT IS A DIAGNOSIS?

Effective treatment and control of fish diseases requires an accurate diagnosis. In simplest terms, diagnosis of disease is the ability to distinguish one disease from another. Although this sounds easy - it is not. Diagnosis is complex because it requires an evaluation of both clinical signs and laboratory examination to identify pathologic changes and etiological (causative) agents.

A clinical diagnosis is based on the observable evidence of disease. When we "listen to our fish" we are observing clinical signs. Examples include feeding behavior, balance, movement, color, reflexes, place in the water column, respiratory rate, and gross lesions. Clinical signs are often the same for several diseases. Therefore, by themselves they seldom supply enough information to identify specific diseases. For example, if rapidly breathing fish in a heavily-loaded raceway are showing increased mortality, how can the clinical sign of increased breathing lead to a diagnosis? The rapid breathing indicates that these fish are trying to get more oxygen. However, since there are several reasons for fish to increase their breathing rate, identifying a specific one may require some effort. Here are a few possibilities:

- Low level of oxygen in the water.
- Damaged gills, preventing movement of oxygen from water to the blood (gill diseases, etc.)
- Decreased ability of the blood to pick up oxygen (nitrate toxicity)
- Decreased ability of the blood to distribute the oxygen to the body (i.e., anemia - many causes)
- Decreased blood circulation (heart disease - many causes)
- Increased oxygen demand by the body (feeding, excercise, etc.)
- Psychogenic (weasel in the tank)

Above list illustrates why clinical observation may not necessarily supply enough information to identify the specific reason(s) for increased breathing and/or mortality. We must go further. A more precise diagnosis can be made with laboratory examination. Laboratory diagnosis are conveniently separated into etiologic diagnosis, the causes of the disease (typically, bacteria, virus, parasites, toxicant, nutrition or genetic), and a morphological diagnosis which is a description of the type and the extent of the damage to the fish.

Morphological diagnosis: This is a diagnosis based on the changes which occur in organs and tissues during the development of a disease. It is a description of the damage to the fish's tissue and the fish's attempt to repair the damage. And since tissue damage is often unique for specific diseases a morphological diagnosis can be very helpful in identifying the cause.

Etiological diagnosis: This is a diagnosis of disease by identifying disease agents in the sick fish. Historically, fish diagnosticians have concentrated on the identification of bacteria and viruses. And, although only a few diseases are caused by bacteria and viruses, isolation and identification of a specific disease agent is an important step in arriving at an accurate diagnosis.

Identification of a disease agent, however, is not synonymous with establishing an accurate diagnosis. We must still separate out secondary opportunistic and latent infections. These are all situations where a disease agent may be isolated from a diseased fish yet the agent isolated is not responsible for the disease. For example, it is possible to isolate the common fish pathogens responsible for bacterial kidney disease, furunculosis vibriosis infectious pancreatic necrosis, infectious hematopoietic necrosis, costia and ichthyophthiriasis from healthy fish or fish which have died from other causes. Therefore, we must be careful when interpreting data from etiological investigations that the clinical and pathological evidence supports the etiological diagnosis. Otherwise we are likely to be treating the diagnosis - not the fish!

Another major problem is the inherent lack of accuracy in most diagnostic tests. Tests may fail to detect the presence of a disease agent when the disease agent is indeed present (false negative) or the tests may indicate that a disease agent is present when indeed it is not (false positive). In day-to-day diagnostic work the presence of false positives and false negatives are more of a nuisance than a major problem. This is because we usually work with more than one specimen and do more than one test. However, for screening and certification purposes the presence of false negatives and false positives are very important.

Source: Brad Hicks, **Canadian Aquaculture**, July-August 1988.

MANAGEMENT OF PRAWN DISEASE PROBLEMS

In order to prevent and control economically important shrimp and prawn diseases, it is essential that hatchery and farm personnel are involved in integrated health management programs.

Treatment of these diseases is often necessary, and numerous treatments are described in the literature. Disease prevention, though, is the goal to strive for in any health management program. This is best achieved by providing optimal environmental and nutritional conditions and practicing good husbandry and management, thereby minimizing stress. Routine monitoring of the health, growth, and survival of the shrimp or prawn population is an important consideration. Probably the best principle is to establish the cultured population into "sanitary lots", segregating groups of shrimp of the same age and isolating them from other groups, thus limiting the risk of the infection spread.

The potential vectors of contamination - such as water, tanks, equipment, algae, **Artemia**, feed materials, workers, predators, and the shrimp themselves - must be properly managed or controlled to prevent horizontal and vertical transmission of disease-causing microorganisms. Considerations include attention to sanitation, disinfection and hygiene of tanks, equipment, materials, and facilities; adequate dryout periods of tanks and ponds between batches; restricted entry procedures; and quarantine and avoidance of indiscriminate stock movements. Prevention by these means will always prove more successful and economical than attempting to control disease outbreaks after they occur. Chemotherapy should only be used for specific disease problems which have been properly diagnosed.

Source: **Fish Farming International**, Vol. 15, No. 8, August 1988.

RECENT PROGRESS IN PRAWN DISEASE CONTROL

There have been a number of interesting new developments in the prawn disease control field. Dr. Y. Takahashi and his colleagues have shown the improved therapeutic effects of antibiotic tablets in the treatment of vibriosis in shrimp. The success of such preparations suggests that an improved method of incorporating nutrients into the diet such as microencapsulation could also be an effective way to deliver treatments such as antibiotics to cultured shrimp, which would be of particular value in the hatchery.

Drs. Lewis and Lawrence have shown that under experimental conditions **Vibrio** bacteria are able to elicit an immune response in penaeids, suggesting that immunoprophylaxis may be applicable in the control of certain penaeid bacterial diseases. More work is required to confirm the diseases. More work is required to confirm the efficacy and practicality of vaccines under routine commercial culture.

Improved standardized techniques for the investigation of viral diseases are particularly needed and definite progress is being made, in addition to light and electron microscopic methods.

Dr. T. Sano and his group at Tokyo University of Fisheries have developed an indirect fluorescent antibody technique for BMN and Drs. Diamant and Colorni have introduced an acridine orange fluorescence method for detecting viral infections characterized by intranuclear or intracytoplasmic inclusions in host target cells. Dr. H. Lewis has also developed an enzyme-linked immunosorbant assay (ELISA) technique for detecting penaeid baculovirus.

Drs. Chen and Kow have recently successfully established the first monolayer cultures from **P. monodon** infected with baculovirus and subcultured six times. Hopefully, these experimental methods will lead to the development of inexpensive, practical techniques which can be routinely used by farmers and their veterinarians to identify viral infections in shrimp culture.

Another area which urgently requires attention is the planning and implementation of comprehensive regulations regarding the use of certain chemicals and drugs. Their injudicious and widespread use is hazardous not only to the shrimps and prawns but also to other animals and humans.

Of particular concern is the uncontrolled prophylactic use of antibiotics. This practice should be discouraged to prevent the development of transferable drug resistance and the selection of genetically resistant strains of bacteria. It is notable that the antibiotic chloramphenicol, reserved for the treatment of human typhoid fever and banned from use in veterinary practice in most western countries, is still widely and indiscriminately used as prophylactic in a number of developing shrimp- and prawn-

producing countries. If this becomes widely known, it is very likely to result in the banning of imports from such countries.

Disease control strategies must also include regulations regarding practical methods to prevent introduction and spread of diseases, especially viruses. Important consideration should include quarantine and monitoring of newly received shrimp and importation and exportation of only certified disease-free post-larvae and broodstock. Regulations must also be devised regarding the disposal of potentially infected culture system effluents and dead prawns.

Development of practical and effective disease control strategies requires the active participation and cooperation of aquaculturists, aquatic biologists and pathologists, all sharing the ultimate aim of producing a bountiful harvest of healthy shrimps and prawns, the basis of a thriving industry.

Source: **Fish Farming International,** Vol. 15, No. 8, August 1988.

AFN-VI-6-4

SPOTTING FORMALIN IN FISH IS NOT EASY

Detecting the presence of formalin in fish sold in the market is no easy task, Philippine Health Secretary Alfredo Bengzon wrote Consumer Watch of the **Manila Chronicle.**

Secretary Bengzon cited three reasons:

First, the amount of formaldehyde (the active ingredient in formalin) found in fish is only 0.5 to 1.0 part per million and can only be determined through sophisticated laboratory tests.

Second, the Health Department has so far received no reports of illness linked to contaminated fish. According to the Health Secretary, several studies have shown that "humans are able to drink as much as 200 milligrams of formaldehyde daily for 13 weeks without symptoms." He explained this to be the equivalent of "eating every day 200 kilograms of fish containing one part of formaldehyde per million."

Third, there is still scanty scientific information on the side-effects of eating contaminated fish.

Secretary Bengzon informed the **Chronicle** that the Department of Health is working with the Bureau of Fisheries and Aquatic Resources, and the Bureau of Food and Drug on the formalin case.

He also added that the use of formaldehyde as food preservative is not allowed.

Source: The Manila Chronicle, November 9, 1987.

AFN-VI-6-5

AQUACULTURE CONSULTANCY: CHOOSING A CONSULTANT OR ADVISOR

In hiring the services of a consultant or advisor, the would-be client should pay particular attention to the following:

1) **The client and project record.** - Be prepared to contact previous clients, and discuss if possible the project results. This will sometimes be subject to confidentiality, but it should be possible to find out basic information on whether the consultant was able to carry out assignments reliably and effectively. Don't be impressed by "highly confidential" credentials or statements such as "we'll only be able to tell you if you hire us" or "only we know how to make this really profitable."

2) **The attitude of the consultants.** - Do they admit mistakes? It is the only way of learning from them, and there is a lot to learn in aquaculture. Are they slick and fast? Too slick and fast? Are they prepared to stop a project if it looks unfavorable? Do they respect confidentiality? Yours?

3) **The role of the consultant in previous projects.** - What specifically was the task of the consultant, with whom and under what circumstances did they work, what were their responsibilities, and how were they carried out?

4) **The resources available.** - Who are the people, what is their depth and breadth, do they have too much other work on hand, do they hire staff or sub-contract work? In certain cases, consultant groups act more as employment agencies - recruiting people as new work arises. This can be effective enough under good management control, with individuals who have worked together before. It also helps to keep down overhead costs, but can, of course, lead to risks.

5) **The overall price.** - Remember that the daily rate is not the only important factor, as this may include substantial backup resources, which enable a job to be done quickly and efficiently, or may reflect particular and valuable skills. Remember the adage "pay peanuts, get monkeys" but don't pay gold and get thieves! Try to establish what you are getting for the money and that there are no hidden extras!

6) **Indemnity insurance.** - It is sometimes suggested that if a consultant carries indemnity insurance this can be taken as a sign of good professional standing, as well as offering some security for the client. While this can be a useful guide, certain professions require that their members carry direct responsibility, in which case membership and good standing in the appropriate professional society may be more important.

7) **Methods and style of work/personal approach.** - This is particularly important for longer-term work. It is very important that a good working relationship be established, with good communication, and a clear understanding of respective roles and responsibilities. Personal qualities or company style may be particularly critical if the consultant will represent you or act for you at any stage.

Source: James Muir, **Infofish International**, No. V, September-October, 1988.

WHAT CAN YOU EXPECT FROM CONSULTANCY SERVICES?

The following offers to would-be clientele an explanatory or cautionary guide before he considers hiring an aquaculture consultant:

1) **Guidance in areas outside your own field of activity.** - This is perhaps the basic and most obvious role of the consultants, where their specific expertise, and their wider background in the field should have particular value. Typical areas of work might include market and feasibility studies, project formulation, and site and environmental surveys. However, as this is the area where by definition you know less than the consultant, this is where good communication, trust, and reliability may be most important.

2) **Specialized inputs to work you are already involved in.** - In these circumstances, it is usually possible to be quite precise about the inputs you require, and who would be capable of supplying them. This is usually less "open-ended" than the first case, and may be more effectively controlled.

3) **Backup for your own staff.** - This may be useful if your own staff, though suitably qualified, are too fully occupied to take on additional development work. If a good relationship can be established, this can often be very effective, as staff can also benefit from the wider experience which the consultants have gained in other parts of the industry.

4) **Comprehensive design and project management services.** - Many consultancy groups, particularly those with an engineering basis, offer this type of service, in effect leaving the developer as the source of investment funds, security, and possibly resources such as land, water supplies, etc. Depending on the quality of services offered, particularly if tied in with a performance-related contract, this can be an effective approach.

5) **Production management services/troubleshooting.** - This is often supplied by specialists in aquaculture management, whether on a longer term basis, or for specific short-term tasks. Again, performance-related contracts can be effective. Note, however, that it is unwise to expect or ask for "quick fix" solutions in troubleshooting - too often these "quickly unfix!"

6) **"...where angels fear to tread".** - Consultants can, of course, be useful as outside advisors in possibly difficult or controversial issues, where (ideally) their broad background and detachment from local issues can give a useful perspective, and possibly some means of resolution - if only for everyone to gang up against the consultant.

Source: James Muir, **Infofish International**, No. V, September-October, 1988.

MARINE THREATS AND THE PHILIPPINES' RESPONSE

Due to unprecendented progress in industry and technology, concern for the marine environment has recently become of major importance. Thus, a comparatively new phenomenon, marine pollution, has become a very important part of worldwide concern for the protection of the environment.

The marine waters and coastal areas of the ASEAN subregion are threatened by both the forces of nature as well as by human activities. Foremost among these threats are siltation; pollution from domestic and industrial wastes; heavy metals; agrochemicals, particularly pesticides; pollution resulting from oil spills from tankers and from onshore and offshore drilling for oil and minerals; and thermal pollution in areas near power plants. In addition, the vast ecosystems of mangrove forests, coral reefs, and intertidal flora and fauna of the region are threatened by the reclamation of land for multipurpose uses and by recreational activities.

In the Philippines, prevention and control of marine pollution is governed by Presidential Decrees (PD). PD 600, amended by PD 979, declares illegal and punishable pollution of the seas by dumping of wastes and other matters, including discharge of oil and other harmful substances within the territorial jurisdiction of the Philippines. Through PD 601, the Philippine Coast Guard can enforce laws and promulgate and implement rules and regulations for the prevention of marine pollution in coordination with the National Pollution Control Commission. PD 602 established the Oil Pollution Operations Center in the Philippine Coast Guard Headquarters. The Center is charged with preventing, mitigating or eliminating damages to marine resources as a result of pollution. In recent years, the Philippine Coast Guard also issued Rules and Regulations for the Prevention, Containment, Abatement and Control of Marine Pollution. Chapter XIV of the Philippine Merchant Marine Rules and Regulations contains provisions on the transportation of dangerous goods.

In addition, the Philippine Environment Code contains provisions on the regulation of disposal, discharge and dumping of wastes that may pollute any body of water, and prohibition on dumping or disposal of solid wastes into the sea or any body of water in the Philippines. Shorelines and riverbanks, from where the wastes are likely to be washed into the waters, are also protected by this code.

Source: Amado S. Tolentino, Jr., "Legislative Response to Marine Threats in the ASEAN Subregion." AMBIO, a Journal of the Human Environment, Vol. XVII, No. 3, 1988.

KNOW YOUR LEAD PROGRAM

LEAD OR THE Livelihood Enhancement Agricultural Development is an assistance program of the Department of Agriculture (DA) for the rural communities to undertake livelihood program in agro- and fishery-based enterprises with the objective of engaging in income-generating projects to increase farmers' income.

PROJECT DESCRIPTIONS

Projects to be assisted by the LEAD bank-assisted program are agriculture-based, value-added, income-generating, and bankable pure business enterprises. The program shall cover all regions of the country. Target beneficiaries of the program, which initially is scheduled for over five years, are the organized farmers' groups that have specific proposals on livelihood development.

COMPONENTS

The program has three components designed to assist the small farmer groups in securing credit from commercial banks:

1. Project Packaging

This component seeks to offset the lack of project packaging know-how by farmers' groups. Existing farmer groups and other non-governmental organizations (NGO's) assisting farmers' groups can identify possible livelihood projects within their locality through the assessment of needs, problems, and opportunities.

The projects shall be site-specific and community-based. Project proposals shall be submitted to the Provincial Agricultural Officer (PAO) who, in turn, submits the proposals to the DA Regional Director (RD) for validation. The validated proposals are then forwarded to the DA Agribusiness Group for evaluation.

The DA Agribusiness Group shall screen the proposals to ensure they fall under the project types to which the LEAD bank-assisted program can provide assistance. Feasibility studies for proposed projects shall be undertaken to illustrate their viability. The studies shall look into alternative schemes to attain the project's objectives and ascertain which alternative would yield the greatest benefits.

Upon completion of the feasibility studies, the Agribusiness Group shall evaluate, select, and prioritize the proposed projects shown to be feasible.

2. Enterprise Management

To remedy the lack of management track record of farmers' groups the Management Association of the Philippines (MAP) has agreed to assist the DA in this area. The MAP will be responsible for evaluating and selecting qualified managers for common livelihood projects as well as pay their compensatoin for one to two years.

The provision of professional managers will hopefully make their projects acceptable to commercial banks.

3. Commercial Banking Linkages

This component is in response to the lack of linkages with commercial banks, collateral and equity. Feasible project proposals shall be referred by DA to commercial banks for financing through it's linkages between farmers' groups and commercial banks. The DA has also mobilized government guarantee mechanisms such as Guarantee Fund for Small and Medium Enterprises (GFSME), Quedan Guarantee Fund Board (QGFB) and Philippine Crop Insurance Corporation (PCIC).

To ensure the sustainability of the livelihood projects to be implemented, the DA shall provide necessary support services such as training, extension, and marketing assistance. Farmers' groups can be trained by DA personnel in the areas of post-harvest, processing and marketing.

The DA can also assist in establishing marketing linkages between farmers' groups and trade/business firms. Marketing contracts can be drawn up to protect the small enterpreneurs from unfair terms and conditions the buyers may impose.

Source: Aggie Trends, Vol. III, No. 2, June 1988.

22 GRADUATE FROM BRACKISHWATER POND CULTURE COURSE

Twenty-two trainees graduated Nov. 16, 1988 from the Brackishwater Pond Culture Training Course conducted by the SEAFDEC Aquaculture Department at its Tigbauan Research Station and Leganes Brackishwater Station. Coming from eight different countries, the trainees were Ioneba Temoai - Kiribati; Abdul Malik Othman, Tony Fu - Malaysia; Arturo Bernaje, Rey Cabalde, Virgilio Gasacao, Antonio Lopez, Rock Eliseo Garay, Edwin Deles, Mario Go, Margarita Chan, Yolanda Cabasal, Vincent Miles, Julius Sabater, Rey Banate, Cornelio Borres, and Eugenio Jose - Philippines; S. Thayaparan - Sri Lanka; W. Chutchawanchaipan - Thailand; Ulungamanu Faanunu - Tonga; Timothy Twongo - Uganda; and Nguyen Anh Tuan - Vietnam.

The training imparted the basic skills and techniques in nursery and grow-out pond culture management of finfishes (milkfish, sea bass, siganids) and crustaceans (prawns and shrimps).

The participants were taught to choose suitable species for culture; select appropriate sites for pond culture; apply basic engineering principles in pond design and construction; handle, transport, and acclimate fry properly for stocking; stock, grow, and harvest the cultured species using recommended pond culture techniques; identify and grow common natural food organisms suitable for the cultured species; formulate and prepare feeds suitable for the cultured species; monitor and detect early signs of disease and implement preventive and control measures; and analyze the economic viability of various cultured species and prepare feasibility studies.

Course topics included pond design and construction, fry handling and transport, harvest and post-harvest technology, and marketing and economic assessment. Course emphasis was on the semi-intensive culture system.

Laboratory work included water and soil analyses and feed preparation and analysis. Practicum activities involved fry handling; nursery and grow-out tecniques, including pond preparation, water management, feeding, harvest, and post-harvest techniques. Field trips to private grow-out farms and nurseries and processing plants were also conducted.

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