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Inland Water Resources and Aquaculture Service
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EDITORIAL

Global aquaculture annual production has reached over 12 million metric tons and continues to grow at approximately 10 percent annually. At present most of the fin fish and crustacean production comes from pond culture of various kinds and the total contribution from pen and cage culture is negligible. Moreover, production from pond culture is expected to increase steadily because of gradual intensification of existing pond culture systems to raise production per unit area, as well as the additional water areas that are expected to be brought under pond culture in the future years.

The advantages of pen and cage culture systems are that they can be carried out in all kinds of inland and coastal waters (perennial and seasonal) including coastal lagoons and bays, floodplains, rivers and canals, lakes (natural and man-made) and reservoirs without much capital investment; and that the technology and the size of the operation could easily be tailored to the ability and the resources of the fish farmer. Among the required inputs, feed may pose the biggest problem. However, this problem could be minimized by selecting the right kind of species for culture depending on the availability of natural feed in the water and the artificial feed in the neighbourhood. Pens and cages could be built with locally available material and the family members of the fish farmer could take active part in the day to day management including feed preparation and feeding. What may be required to ensure success are a reliable supply of fingerlings and a dedicated extension service.

In many developing countries there exist vast water areas that could be used for some kind of pen and cage culture, as a part of the overall rural development programme, with a view to alleviating poverty and improving nutritional status of rural people. Some developing countries such as China, Philippines, Thailand and Nepal has made some noteworthy progress in this direction. But, the potential is so high and so little has been achieved. The donors, national governments and non-governmental organizations are urged to explore these possibilities.

I hope, I have not made it sound too easy. Dear colleagues, we all know nothing is easy in this game. In any case, this is something to think about.

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AQUACULTURE NUTRITION FOOD FOR THOUGHT

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Introduction

As in terrestrial farm animals, the growth and production of farmed fish and shrimp is dependent upon the intake of food containing 40 or more essential dietary nutrients, including proteins, lipids, carbohydrates, minerals and vitamins. At present the cost of supplying these dietary nutrients represents the largest single cost item of most semi-intensive and intensive fish and shrimp farming operations; food and feeding costs generally accounting for 30-60% of total farm production costs, and sometimes even higher.

Need for a Definition

Aquaculture nutrition is concerned with the study of those processes by which a farmed fish or shrimp obtains, takes in, and assimilates food for promoting tissue growth or repair. Simple as this definition may appear, the majority of researchers and donor agencies still believe that aquaculture nutrition is only concerned with the formulation, production and utilization of artificial or processed diets for use within intensive farming systems. Since over 80% of world finfish and shrimp aquaculture production is currently realized within semi-intensive and extensive pond-based farming systems, research emphasis must also be given to semi-intensive and extensive feeding methods, such as live food production through pond fertilization or substrate enhancement, and supplementary diet feeding. All too often it is believed that the only economic way of feeding fish or shrimp is by using a high quality 'complete' pelleted diet; it is not, and farmers and researchers alike should not be misled to believe so.

Although all farmed fish and shrimp have the same basic qualitative dietary requirements for the five major nutrient groups (ie. proteins, lipids, carbohydrates, minerals and vitamins), the form in which these nutrients are supplied varies depending upon the farming system employed; varying from the exogenous supply of a nutritionally complete artificial pelleted diet within intensive cage farming systems to the consumption of endogenously produced live food organisms within extensive pond farming systems. The relationship between artificial diets and live food organisms in the overall nutritional budget of fish and shrimp within extensive, semi-intensive and intensive farming systems is shown in Figure 1.

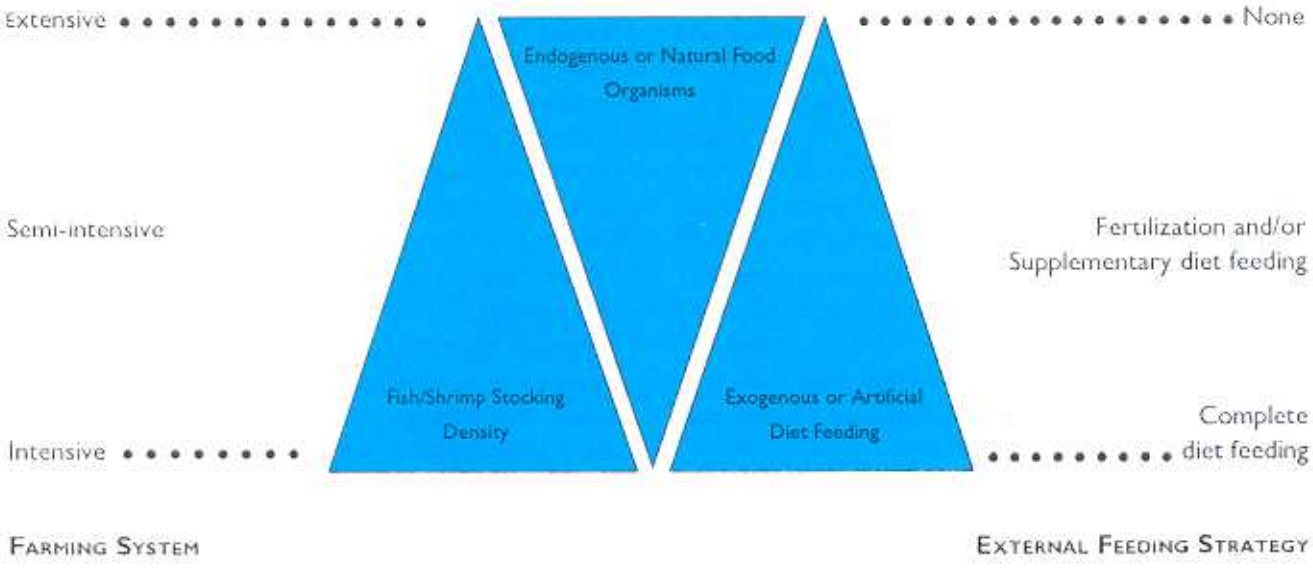


Figure 1: The relative contribution of natural food organisms and artificial feeds in the nutritional budget of fish and shrimp within extensive, semi-intensive and intensive farming systems

EXISTING FEEDING OPTIONS

Existing aquaculture feeding practices can be broadly divided into four basic food management options depending upon the level and form of the nutrient input into the farming system, namely:

No exogenous nutrient input - basic farming system where fish and shrimp growth is totally dependent upon the natural productivity of the water body in which the fish or shrimp are cultured and the consequent consumption of naturally available food organisms. This management option is generally employed within extensive farming systems in large water bodies or ponds with low fish or shrimp stocking densities.

Fertilization - chemical fertilizers and/or organic manures are used as a source of nutrients to enhance the production of live food organisms within the water body in which the fish or shrimp are cultured, and so increasing the fish/shrimp production capacity of the culture system. Organic manures include the use of animal manures (applied manually or through livestock integration), green manure (fresh plant cuttings), and fresh or composted agricultural by-products. This management option is typical of a semi-intensive farming system.

Supplementary diet feeding - the use of exogenous feeds as a supplementary source of dietary nutrients for direct consumption by the cultured fish or shrimp. The dietary nutritional requirements of the aquaculture species are supplied by a combination of live food organisms and supplementary feed. Supplementary feeds usually consist of low-cost locally available agricultural materials and by-products, and may include live or fresh natural food items (ie. macro invertebrates - insects, annelid worms, crustaceans, molluscs; terrestrial and aquatic macrophytes; animal slaughter-house offal) and/or the use of one or more processed feed items (ie. mill sweepings, rice bran, oilseed residues etc.) in the form of a feed mash, dough ball or pellet. Processed feed ingredients include all animal and plant food items and wastes which have been physically processed prior to feeding either by drying, fermenting, grinding, pelleting or by mixing with other food items into a compound diet. Supplementary diet feeding strategies generally allow higher fish and shrimp stocking densities when used in conjunction with pond fertilization, and are typically employed within semi-intensive farming systems.

Complete diet feeding - the use of an exogenous feed as a complete source of dietary nutrients for direct consumption by the cultured fish or shrimp; the dietary nutritional requirements of the aquaculture species being entirely supplied by the complete feed. Traditionally, complete diets have taken the form of dry

or moist pelleted feed consisting of a combination of different processed feed ingredients, the overall nutrient profile of which approximates as far as possible to the known dietary nutrient requirements of the cultured species. In addition, complete feeds may consist of the continuous use of single natural food items of high nutrient value such as 'trash fish' or hatchery cultured live food organisms (ie. Artemia nauplii and adults, rotifers, algae etc.), or a combination of both. Complete diet feeding is normally employed within intensive farming systems, and because of the high fish or shrimp stocking densities employed no nutritional benefit is assumed to be gained by the cultured aquaculture species from natural food organisms present within the water body.

Choice of Feeding Strategy

A prerequisite to the selection of appropriate fertilizers and feeds for use within an extensive, semi-intensive or intensive farming system is first to conduct a survey of the fertilizer and agricultural feed resources of the area, district, state or country in question, with a view to identifying where these resources are geographically located, how much is available and when, who is currently using this resource and how, and the cost of these resources. Clearly, the resident aquaculture sector must be made aware of the national agricultural feed resources available to them and how they can best use these resources (whether it be poultry manure, coffee pulp or fishmeal) within aquaculture feeding strategies. Such an approach is essential if countries are to develop their own national aquaculture feeding strategy and reduce their reliance on imported feed ingredients and 'ready-made' feed technology packages.

In addition, many economic, social, biological and environmental factors will have to be considered by the farmer before choosing an appropriate fertilization, supplementary diet or complete diet feeding strategy, including:

- Supply and demand of the species to be farmed
- Market value of the species to be farmed
- Financial resources of the farmer (ie. capital available for investment and operating cost)
- Farming traditions, 'taboos', and managerial ability of the farmer
- Time available for the farming activity (ie. full or part-time)
- Labour availability, training requirement and cost
- Service availability and cost (ie. water, electricity, fuel)
- Fertilizer and feed availability and cost
- Fertilizer and feed transport and processing cost
- Feeding habit of the target species (ie. herbivore, omnivore or carnivore)
- Dietary nutrient requirements of the target species
- Water quality requirements of the species to be cultured
- Intended farm production unit (ie. pond, pen enclosure, cage, raceway, tank)
- Intended stocking density of the target species
- Natural productivity of the water body
- Feed performance in terms of fish/shrimp growth, feed efficiency and production
- Food and feeding cost/unit production/unit time.

The relative importance of these individual factors will in turn depend on whether the proposed farming activity envisaged is geared toward a rural/subsistence farming activity for home consumption, a commercial/market based farming activity for cash sale, or a combination of both.

Rural/subsistence-based farming activity

The aim of a rural or subsistence farming activity is to produce fish for home consumption using locally available resources at minimum cost. The intended production unit usually consists of a single earthen pond owned or operated by one or more family units, and the farming activity is small-scale in nature. The farming activity is usually conducted on a part-time basis with little or no funds available for pond construction and the purchase of fry/fingerlings, fertilizers, feeds or farm equipment. Given the above constraints the farmer is faced with the prospect of culturing fish species which require little or no daily management, can tolerate poor water quality conditions, and feed on the lower end of the aquatic food chain, so that he can make maximum use of natural pond food organisms and low value agricultural by-products. Rural farming activities are therefore generally restricted to the culture of herbivorous or omnivorous fish species within semi-intensive or extensive pond conditions.

On the basis of the above discussion it is clear that the feeding strategy to be implemented must be of minimum or no cost to the farmer, is simple to operate and manage, and requires only part-time labour inputs. Of the four basic feed management options available the

most appropriate at the rural or subsistence level is a low cost semi-intensive feeding strategy using a combination of pond fertilization with organic manures (either by direct application or composting, or through integration with livestock) and supplementary diet feeding with agricultural by-products. This feeding strategy will have the necessary flexibility in that fish/shrimp growth is not dependent on a single food source but on a combination of different feed types (ie. natural live pond food organisms and processed supplementary feeds). It is essential that the feeding strategy chosen has this flexibility as fertilizer, feed and labour inputs may vary over the growing season depending on their availability and the financial resources of the farmer.

In view of the shortages and high prices of conventional feed ingredients within rural communities and the low cash income and purchasing power of small-scale farmers, fertilizer and food selection for fish feeding is normally based ,in order of importance, on the following criteria: 1) least cost (ie. the material should be available at little or no cost to the farmer), 2) local availability, 3) easy handling and processing (ie. the handling and processing requirement prior to feeding, including transportation, should be minimum or negligible), and 4) nutritional value. Furthermore, by utilizing low value agricultural products, and in particular those agricultural and agro-industrial by-products which are not usually used for human or livestock feeding, aquaculture could be seen as a vehicle for improving productivity of rural communities.

Commercial/market-based farming activity

The aim of a commercial/market-based farming activity is to produce fish or shrimp for cash sale at maximum profit. Here the most important criteria is the market value and demand of the species to be farmed; the market value dictating the profit margin relative to production costs, including the cost of food and feeding.

Market-based farming activities can be of an extensive, semi-intensive or intensive nature, within pen enclosures, ponds, cages, tanks or raceways. Generally the farming activity involves the use of full-time labour inputs and high capital start-up and operating costs. Feed management options vary from no nutrient input, fertilization, supplementary diet feeding, to complete diet feeding strategies. The choice of feed management option being dictated primarily by the market value of the target species.

A Major Stumbling Block

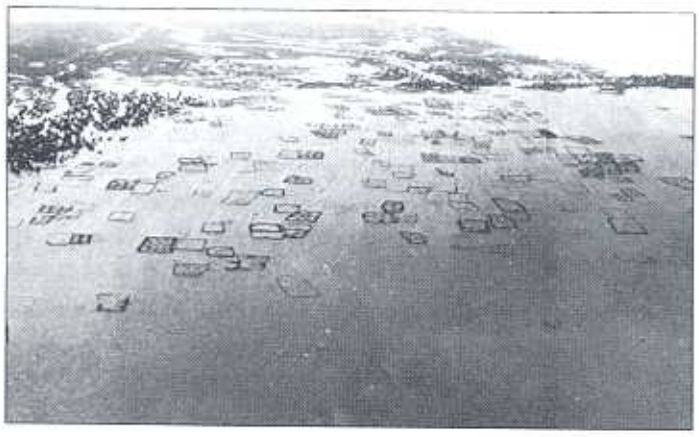
At present almost all of the available information on the dietary nutrient requirements of cultivated fish and shrimp is derived from laboratory-based feeding trials; fish and shrimp usually being housed within indoor tanks at high density and subjected to controlled environmental conditions with no access to natural food organisms. While this information is essential for the formulation of complete diets for use within intensive clear-water aquaculture systems (ie. tanks and raceways receiving clear running water, or cages suspended in open water bodies), this information cannot be directly applied to the formulation of supplementary diets for use within semi-intensive or extensive pond farming systems. In contrast to intensive cold water farming systems where the cultured species is totally dependent upon the external provision of a nutritionally "complete" diet for the entire farming cycle, aquaculture species cultured under extensive and semi-intensive pond conditions derive all or a substantial part of their dietary nutrient needs from naturally available live pond food organisms (Figure 1).

Clearly, the nutrition and feeding of fish and shrimp within each farming system must be considered as being unique and should be evaluated on its own merits. Sadly, one of the major stumbling blocks to aquaculture development within many developing countries has been the direct transfer and application of intensive complete diet feeding strategies to semi-intensive pond farming systems. For example, at present almost all commercial feeds produced for semi-intensive pond farming systems are formulated as nutritionally complete diets irrespective of the fish/shrimp stocking density to be employed and the natural food availability within the system. This situation must be remedied if farmers are to reduce production costs and maximize economic benefit from their semi-intensive pond farming system. This situation becomes totally unacceptable when one considers the facts that 30-60% of the production cost is represented by feed cost and that 80% of world shrimp and finfish production is currently realized within semi-intensive and extensive pond-based farming systems.

An Exciting New Development

Probably one of the most exciting developments to have occurred in recent years has been the application of the brush-park or 'acadja-enclosure' fishing method to extensive and semi-intensive aquaculture farming systems. The farming practice is based on the introduction of woody material (ie. branches, twigs, bamboo) as a substrate or habitat into a pond or pen enclosure containing fish for stimulating the production of periphyton and associated flora and fauna as live food organisms for the cultured fish. Early pen-acadja culture trials within coastal lagoons have produced fish yields equivalent to 8 tons/ha/year (equivalent to eight times higher than pens without acadja). Similarly, preliminary trials with bamboo-acadja's within freshwater tilapia ponds (6 bamboos/m2 substratum) have produced twice the amount of fish (3.6 tons/ha/year) than ponds without bamboos on the substratum. The advantages of the acadja-based farming system is that it requires no external feed inputs, is simple to operate, is non-polluting, and requires minimal cash and labour inputs.

Clearly, the road is open for improvements to be made in the field of aquaculture nutrition so as to address the special and unique needs of semi-intensive and extensive fish farmer. It is hoped that this introductory paper will provide food for thought.



Aerial view of part of the acadja field near the village of Ganvie in the north-west of Lake Nokoue, Guinea

FURTHER READING

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THE IMPORTANCE OF FARM-MADE AQUAFEEDS IN THE ASIA-PACIFIC REGION

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Much has been written and said about farm-made aquafeeds but little numerical information is available about their importance in aquaculture development. To address this issue the FAO Regional Office for Asia and the Pacific (FAO/RAPA) and the ASEAN-EEC Aquaculture Development and Coordination Programme (AADCP) organized and held a meeting in Bangkok from 14-18 December 1992. At this meeting, the FAO/AADCP Regional Expert Consultation on Farm-made Aquafeeds, over thirty experts were assembled to present and discuss eleven country papers and nine working papers and to prepare recommendations for follow-up actions.

Country papers on aquafeeds and feeding strategies in Bangladesh, Cambodia, China, India, Indonesia, Malaysia, Nepal, the Philippines, Singapore, Thailand and Vietnam, gave details about local availability of feed ingredients, industrial aquafeed manufacturing, on-farm feed formulation, manufacturing and feeding strategies, the major institutions involved in aquafeed research and development, current feedstuff regulations, current problems and constraints, and the trends in aquafeed manufacturing and use.

The working papers dealt with important subject matters such as supplementary feeds in semi-intensive aquaculture, formulation and on-farm feed management, feed ingredients and quality control, equipment for farm-made aquafeeds, etc. An overview of the scale and the future trends of aquafeeds in Asia was presented by the authors of this article. Finally, the authors of the working papers and country papers were joined by representatives from the Asian Institute of Technology (AIT), the Bay of Bengal Programme (BOBP), the Overseas Development Authority of the UK, the Aquaculture Department of the Southeast Asian Fisheries Development Centre (SEAFDEC-AQD), BP Nutrition (Thailand), the American Soybean Association (Singapore) and the Vietnam National Sea Products Export Corporation (SEAPRODEX), for discussions.

All the papers presented will be published by FAO and AADCP as the Proceedings of the FAO/AADCP Regional Expert Consultation on Farm-Made Aquafeeds, 14-18 December 1992, Bangkok, Thailand. This book will contain a wealth of details on the utilization of farm-made aquafeeds in Asia. A summary of the findings are presented below:

The bulk of Asian finfish and crustacean aquaculture production comes from semi-intensive pond farming systems. Freshwater non-carnivorous finfish, accounting for over 80% of total Asian finfish production, depend on the use of farm-made feeds. Some intensive systems, such as the culture of snakehead, catfish species and marine fish, also utilize aquafeeds prepared on-farm. It is estimated that while almost 50% of shrimp production depends on commercial aquafeeds, 90% of finfish production in Asia is produced by natural production, enhanced by artificial fertilization or integrated culture, and the use of farm-made feeds. **Farm-made feeds were defined as "feeds in pellet or other forms, consisting of artificial and/or natural feedstuffs, produced for the exclusive use of a particular farming activity, not for commercial sale or profit".**

The nutrition and feeding of finfish and crustaceans in semi-intensive pond systems are complex and poorly understood, due primarily to difficulties in quantifying the contribution of naturally available food organisms. There is an increasing tendency

for farmers to use nutritionally complete commercial aquafeeds, designed for intensive farming systems, in semi-intensive culture, which is a waste of resources.

- Farm-made feeds have significant environmental advantages in that they facilitate the use of locally available agricultural products and the wastes of agro-processing industries, which otherwise will have very limited or no use within the community. However, farm-made feeds often need animal protein as an important ingredient. Animal protein being usually scarce and expensive, alternative ingredients, which are inexpensive and readily available, should be identified.

- Farm-made feeds are potentially cheaper than commercial aquafeeds. Proper use of farm-made feeds can provide opportunities for reducing aquaculture production costs. However, farm-made feeds are suitable only for semi-intensive and a few specific intensive aquaculture production systems. Farm-made feeds are regarded as complementary to, rather than competing with, commercial aquafeeds. Farm-made feeds fill an important need of the small-scale farmers which is not covered by commercial feedstuff manufacturers. However, farmers initially successful through the use of farm-made aquafeeds often later shift to the use of commercial feeds.

The participants in the meeting agreed to recommend a number of follow-up actions which are summarized below:

- The proceedings of the consultation should be widely circulated to governments, international agencies and potential donors with a view to informing them of the importance of farm-made aquafeeds to small-scale aquaculture and of the need for technical support. Future aid for aquafeed development should be channelled to research and development of farm-made aquafeeds. Public sector funding should primarily assist small-scale farmers, not feed manufacturers.

- Pre-conceived ideas should not be forced on to farmers. Future efforts should be concentrated on improving farmers' existing practices and demonstrating their greater profitability. Simple and cheap methods for increasing the nutritional value of locally available ingredients need research. Improved techniques for on-farm processing and storage should be developed and simple inexpensive machinery for these purposes should be designed or identified.

- Experts formulating aquafeeds for on-farm production should utilize locally available ingredients, minimize the use of vitamin premixes, binders and other expensive commodities, and address the nutritional requirements of each farming system. Commercial feed specifications should not be mimicked. In formulating on-farm feed the role of natural food organisms in semi-intensive farming should be taken into consideration.

- Since increases in profitability in small-scale aquaculture are more likely to occur through improvements in feeding strategies than in developing perfect diets, applied research should concentrate on optimizing feeding frequency, methods of feed presentation, reductions in feed wastage in the farming enclosure and during feed preparation and storage, and on farmer-friendly sensory methods of assessing feed ingredient quality. Two-component systems of feed presentation (e.g., feeding high-energy ingredients separately from high-protein ingredients; alternating feeds of different composition; alternating different feeding rates) were also thought worth further study.

- To train farmers in aquafeed formulation, ingredient choice, processing, storage and on-farm feed management, village level training should be organized. Training materials such as instructional manuals, videos and simple booklets should be prepared. Since the level of experience in the use of farm-made aquafeeds varies quite widely among the countries of this region, the transfer of technology through TCDC should be encouraged.

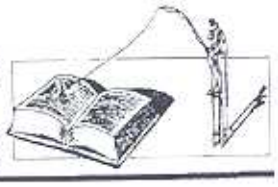
- FAO and donor agencies should collect and collate data/information on farm-made aquafeed production, storage and utilization, and on its socio-economic impacts, on a regular basis.

- Similar consultation meetings should be held at three-year intervals with a view to assessing the progress made and to recommend follow-up actions.

THE FISHERIES BRANCH LIBRARY OF FAO

Jean Collins
Librarian
Fisheries Branch Library

FISHERIES LIBRARY NEWS



The Fisheries Branch Library (FBL) is a part of the David Lubin Memorial Library, the central library of FAO. In 1967 FBL was established in order to meet the demand for specialized subject documentation and information services on fisheries and allied subjects. A team of three, a librarian and two support staff, together with the backup of the Main Library, provide these services to FAO headquarters and field staff.

FBL collects publications on all aspects of fisheries from statistics and economics, through legislative and sociological aspects, to the natural and applied sciences of fisheries biology, aquaculture, fish technology and marketing. The extensive collection which has been built up over the past 25 years presently consists of 1600 periodical titles, over 10,000 books, approximately 12,000 FAO reports and several thousand reports of other fisheries agencies.

An estimate of the proportion of the collection which can be categorized as aquaculture or aquaculture related material gives the following picture:

Periodicals	*150 from 37 countries*
Books	*1020*
FAO documents	*1200*

The collection provides the basis for the documentation and information services provided to FAO staff at headquarters and in the field, which is of course our main task. Some of the services provided and the tools used in disseminating information within FAO will be described in a later issue of FAN.

This article is intended to give a general description of another very important function of FBL, and that is to provide the global fisheries community with access to the published work of FAO on the subject of fisheries. Although FBL does not distribute FAO publications, we provide details as to what FAO has published on a specific topic in response to enquiries. We also provide details of the way to obtain those publications, which varies according to the type of document in question.

Fisheries Department Publications

The Fisheries Department produces some 75 publications a year in the following regular series which are widely distributed:

FAO Fisheries Technical Papers
FAO Fisheries Reports
FAO Fisheries Circulars
FAO Fisheries Synopses
Yearbook of Fishery Statistics

In addition to mandatory distribution to Member Governments and Depository Libraries, the above series are also supplied, by subject category only, to many fisheries institutions and organizations all over the world. They are also available for purchase at designated Sales Agents in many countries. In the absence of a Sales Agent in your country they may be ordered directly from the Distribution and Sales Section of FAO headquarters in Rome.

The Fisheries Department regularly updates the list of these regular series titles, the latest being *FAO Fisheries Circular 100, Rev. 4*, which covers Publications and Documents for the period 1977-1990, and a supplement covering 1991. This is supplied upon request and it includes details of how to order FAO publications.

Fisheries Field Projects Reports

In addition to the fisheries publications produced at headquarters there is a wealth of documentation produced by FAO fisheries projects in Africa, Asia and the Pacific, Latin America and the Caribbean, the Near East, Eastern Europe and the Mediterranean. Of the 142 ongoing FAO fisheries projects, 42 can be said to be aquaculture projects or have an aquaculture component.

These publications, which generally fall into the category of technical reports, working papers, extension manuals etc. are produced in limited numbers and, with the exception of the series of some large regional projects, do not have a wide distribution. In order to bring the work of field projects to the attention of a wider audience, the Fisheries Department produces special subject bibliographies. A recent example is FAO Fisheries Circular No. 849; *The Food and Feeding of Farmed Fish and Shrimp : an annotated selection of FAO field documents 1973-1991*, A. Tacon, 1992. As the author states in his introduction "A prerequisite to the planning and implementation of a research and development activity ... is first to be aware of the previous studies conducted in this subject area by other related field projects, and by so doing avoiding unnecessary duplication of research effort and the re-invention of the wheel".

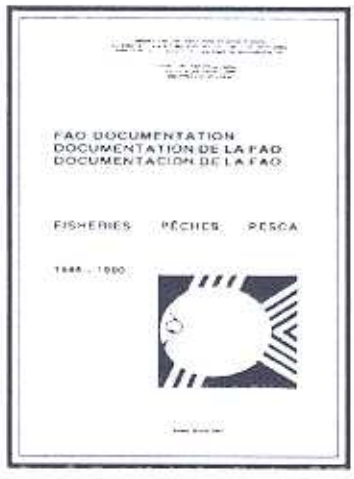
Library and Documentation Systems Division

One of the functions of the Library and Documentation Systems Division (GIL) of FAO is to safeguard and maintain the collection of documents resulting from FAO programmes at Headquarters and in the Field as part of the institutional memory and to disseminate bibliographic data on them with back-up document delivery services.

In order to fulfil its mission GIL collects and microfiches FAO publications and documents and maintains computerised databases to manage this collection and facilitate access to them. The microfiches of documents are available on request and at cost price from the David Lubin Memorial Library.

Retrieval is direct and very easy at FAO headquarters where everyone has access to the computer and the library. However, reaching a much wider audience in very different circumstances and with different information needs requires a variety of products and solutions. The libraries of fisheries institutes in developing and developed countries usually want comprehensive coverage of FAO fisheries publications. An individual working on tilapia culture in Africa may only wish to have information on that specific topic, in a particular language and covering the most recent five years. An aquaculture project in Chile funded by another donor may wish to have details of all FAO fisheries publications on aquaculture in that country or region. The variety of requests seems to be as wide as the scope of fisheries and aquaculture.

Amongst the products derived from library databases to meet these requests are special bibliographies covering all FAO activities on broad subjects. For example *FAO Documentation : Fisheries 1986-1990* updates earlier bibliographies and includes references to all FAO fisheries and aquaculture publications for that period, including field reports.



A product may be a list of references from the FAO Documentation database on a subject tailored to meet a very specific request from a researcher. The range of products available is extensive and includes the contributions of FAO to international databases such as Aquatic Sciences and Fisheries Abstracts (ASFA) and International Information System for the Agricultural Sciences and Technology (AGRIS), but as mentioned earlier we will leave these for another article.

This introduction to the Fisheries Branch Library is intended to increase awareness of our services, and we look forward to hearing from anyone who wishes to avail of them.

GEOGRAPHICAL INFORMATION SYSTEMS IN AQUACULTURE

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Planning and decision making for aquaculture and fisheries development and management are difficult due to the complexities created by the interactions of the various factors involved in the process. Among them are the environmental (physical, chemical and biological), economic, social, cultural and the administrative set-ups of the geographical area being assessed. Geographical information systems (GIS) technology can be used as a tool to aid decision making for aquaculture and fisheries management and development.

But first, what is a GIS? A GIS is a computer-assisted system to store, manipulate, analyze and report spatial data. Think of the data storage, manipulative and reporting capabilities of a powerful data base combined with the algebraic and logical analytical functions of a multi-dimensional spreadsheet. Then add the software and hardware to make maps. That is the operational shell of a GIS. But what about the data?

A GIS can handle any type of data (e.g., physical, social, economic). The only constraint is that the data have to have a location. That is the "spatial" part of the definition. For example, a GIS "sees" a water body as a point or a polygon (a many-sided, closed object), depending on the scale, just as on a paper map. However, unlike a map, each water body in a GIS, apart from its location, can have a number of attributes assigned to it. If the water body happened to be a pond on a fish farm, this could include the depth, yield history and owner's name. If a large reservoir, the attributes of interest could be its fishery potential, fishery performance, limnological characteristics and the number of fishermen fishing there. Also, unlike a map on paper, the map data in a GIS can be readily asked to provide much useful information; for example, the surface area of the water body, the distance to the nearest road, nearest market, extension centre and the like.

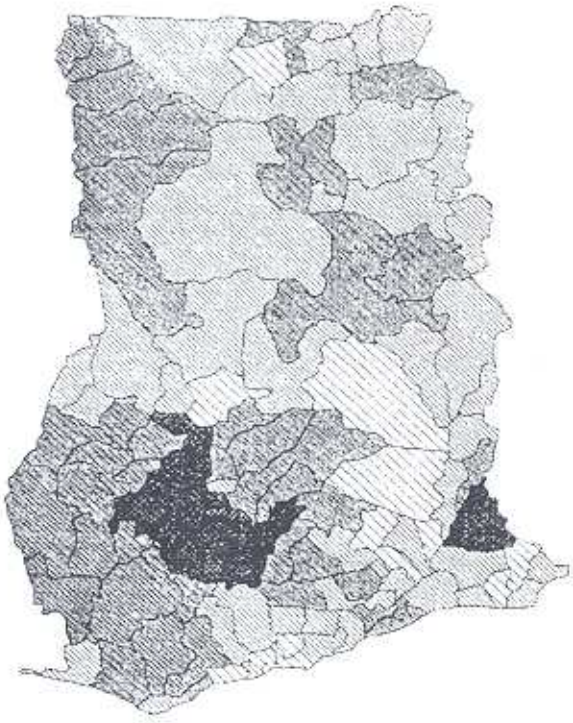
For what kinds of problem solving is GIS used? GIS is especially useful in circumstances where many diverse factors have to be considered to reach a decision, where the factors differ in importance and in situations and where the factors themselves are quite variable spatially. Have you ever tried to compare information from two or more maps at the same time in order to locate where the features of interest coincide? Try it on Figure 1. Not easy, particularly if the maps are at a different scale. With the help of a GIS, each map showing a different "theme" such as availability of inputs and locations of markets can be produced. Then the thematic maps can be laid one over the other in order to analyse the thematic inter-relationships. Finally, the areal estimates pertaining to each inter-relationship can be generated. In summary, GIS works well for complex situations.

What has the FAO Fishery Resources and Environment Division (FIR) been doing with GIS? Since 1985 it has been FIR policy to promote GIS along with remote sensing (RS) as tools for the management and development of fisheries and aquaculture. The promotional activities have included regional GIS/RS appreciation workshops in Asia, Latin America and Africa; the integration of GIS into Field Programme and Technical Cooperation Programme (TCP) projects; and the production of GIS/RS related technical papers and reports. For example, FAO Fisheries Technical Paper 318 provides a background on GIS/RS theory and practice and uses case studies to illustrate their applications. Another method of promotion by FIR has been presentations of papers on GIS and RS applications at seminars and workshops conducted by other organizations.

An example of the use of GIS as a tool for decision-making in fish farming development is from Ghana. Under a TCP project of FAO, a GIS was developed to assess the capability of each of Ghana's 110 districts to

support fish farming. Each district was rated according to the following criteria: availability of water throughout the year, soils suitable for ponds, inputs, markets, technical assistance, agglomeration, and welfare. By employing a number of different models in the GIS, fish farming potential could be looked at from the differing points of view of a government decision maker and an entrepreneur. Similarly, by taking into account the present distribution of fish farms, unrealized potential could be highlighted in the districts with favourable physical and economic environments (Figure 1).

a)



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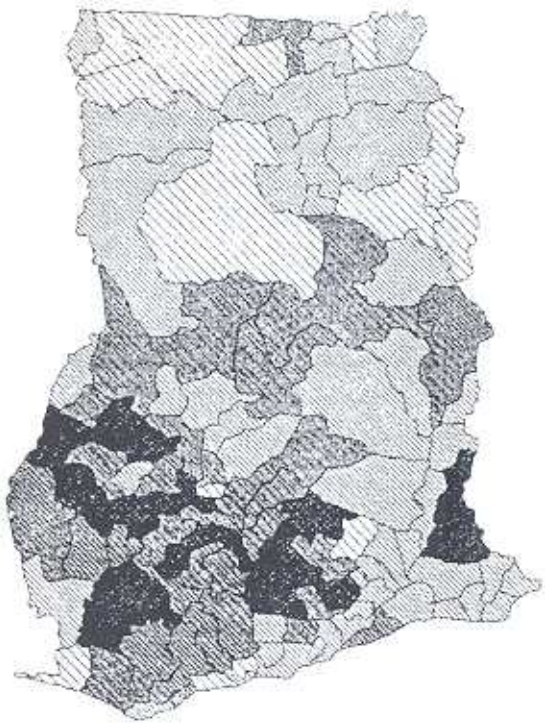

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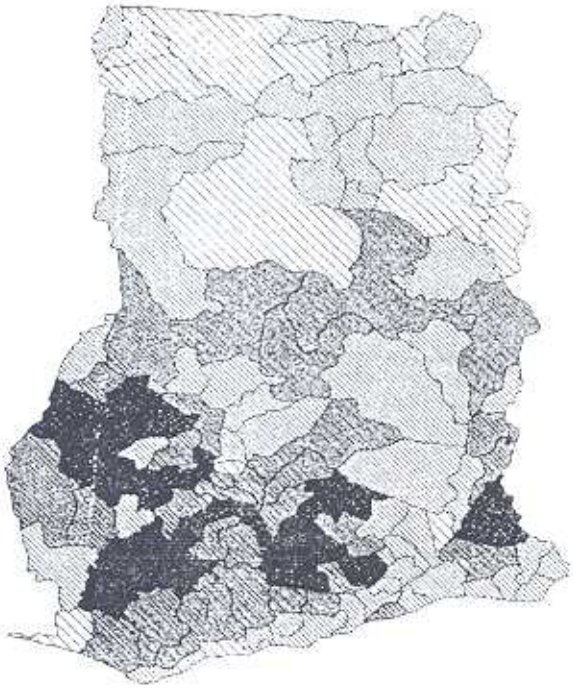

Figure 1: the capability of 110 districts to support fish farming in ponds. (a) is a government decision maker's model; it includes welfare. (b) is an entrepreneur's model; it focusses on good physical and economic conditions. (c) is a model that emphasizes good opportunities for fish farming in districts where it is little practiced or does not yet exists. (note : darker and denser signify better capabilities)

The Inland Water Resources and Aquaculture Service (FIRI) of FAO will be implementing a number of GIS activities in the near future, which will be of interest to fishery and aquaculture workers. This year, for example, FIRI will begin a GIS for the inland fishery resources of Africa. A data base of about 1,000 water bodies with their physical, limnological and fishery characteristics has been prepared. It will serve as the input. The objective is to compare actual fishery performance with fishery potential. In this way, technical assistance can be focused on those water bodies which are not living up to expectations.

Another FIRI activity is the GIS-assisted Strategic Assessment of Fish Farming Potential in Africa. The pilot phase of this study has just been completed. The objective was to identify the areas with the best potential for warm water fish farming from a continental perspective. Fish farming potential was assessed using a broad variety of criteria. These included availability of surface water for storage in ponds, suitability of topography and soil texture for pond construction, temperature regime to permit two crops per year, availability and variety of agriculture by-products as inputs, road, infrastructure and local market potential. Also considered were acceptability of fish in the diet, present level of fish farming, fish supply and demand, and purchasing power of the consumer. The inclusion of market and socio-economic criteria in the study made it possible to identify the areas with possibilities for commercial fish farming. The GIS thus created was used to evaluate the various criteria on 10' (18 km x 18 km) grids and by country boundaries.

The preliminary results from this study indicate that there are 29 countries with areas that range from suitable to optimum for warm water fish farming. It is important to keep in mind that this study set out to identify the areas where two crops per year are possible using Nile tilapia and *Clarias gariepinus* and that rather stringent conditions were placed on the criteria. With changes in criteria such as one crop per year of warm water fish species or farming of temperate/cold water fish species, the GIS is expected to give a very different picture. In fact, the second phase of the "Strategic Assessment" will set out to define just these kinds of fish farming opportunities. Part of this study will be carried out in cooperation with FAO/Sweden project "Aquaculture for Local Community Development (ALCOM)".

Meanwhile, the UNDP/FAO/Zimbabwe project "Support for Rural Aquaculture Extension" is developing a national-level GIS. The GIS is focused on the development and management of more than 10,000 small water bodies in the country. However, with little additional input, the same GIS can be used for defining fish farming potential in Zimbabwe. The GIS uses basically the same criteria as for the Africa-wide GIS, but because of its finer resolution, it will be able to "zoom in" to undertake studies similar to those described above for Ghana.

Although the focus of this article is on GIS in aquaculture, it is noteworthy that FIRI's sister organization, the FAO Marine Resources Service (FIRM), also is active in GIS with West Africa as the geographical focal point. A pilot study has just been completed and this relates the demersal fishery resources off Senegal and the Gambia to bathymetry and bottom types. The study was meant to test the GIS approach. It succeeded in demonstrating the potential of GIS as a tool for the management of fishery resources, and it has also revealed some of its constraints.

I have brought in the marine GIS example in order to make several points. One point is that a GIS can be made synoptic in order to cover both aquaculture and fisheries at little additional cost. This is because the fundamental data are the same, or nearly so. For example, a GIS for coastal marine fisheries would include bathymetry and salinity, both of which are important for mariculture development and management. Likewise, there are many kinds of information needed for management and development of inland fisheries that are also common to fish farming development (e.g., infrastructure, processing facilities, markets). Extending the idea even further, it is readily apparent that concern for the environment (in the broadest sense) is common to aquaculture and fisheries, no matter where they are practised. GIS is the tool to spatially link and to conceptually integrate the complex data that are needed for effective management and sustainable development of fisheries and aquaculture and for ensuring a productive aquatic environment.

But is GIS for everyone? Probably not. First, not all fishery organizations can justify a full-time GIS. One-time studies, such as fish farming potential, are probably better done on contract, or as components of technical assistance projects. Secondly, implementation of GIS requires a long-term administrative and financial commitment. Even though GIS software is relatively inexpensive and there are

versions that run on PCs, personnel have to be trained and permanent posts have to be established. Furthermore, the hardware has to be maintained and software and equipment have to be upgraded. Also, data bases require periodic up-dating. In cases where a fisheries and aquaculture GIS can be justified, it makes economic sense to link it to a central government institution, where a functional GIS already exists, in order to save on costs for personnel, equipment and facilities and to take advantage of data sharing. FAO, for example, has a Central GIS that serves all of its departments. An alternative to a fullfledged GIS can be a desktop information system (DIS). The DIS could be used to manipulate and report data for "what if" kinds of analyses, but it would lack sophisticated GIS analytical capabilities.

There are a number of positive developments in GIS technology that will help to accelerate its use in fisheries and aquaculture. One of them is the availability of maps in a computer-usable (digital) format. For example, the US Defense Mapping Agency is producing the Digital Chart of the World (DCW) at 1: 1 million-scale. It is inexpensive and available on CD-ROM. It combines major transportation routes including roads and railroads, canals, population centres, elevations and contours, coastlines, water bodies and international boundaries. Thus, the DCW can be used as a base map for many national, or regional-level GIS studies. Another positive development is that, in cases where paper maps still have to be digitized, scanners now can be used for what previously has been expensive, tedious, time-consuming "electronic tracing" by hand.

In summary, GIS in fisheries and aquaculture has come to the point where technology is no longer a constraint; and also there is an increasing awareness among the planners and decision makers of the kinds of management and development information that can be best acquired by using a GIS.

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THE FAO FIELD PROGRAMME

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In the first issue of the FAO Aquaculture Newsletter, as an introduction for our readers, an article on the FAO role in support of aquaculture development and on how the FAO aquaculture programme has evolved through the years was included.

This article could be considered as a follow-up of that previous one and is intended to familiarize our readers with the way FAO's work in aquaculture is organized. To recapitulate a little, in the first issue it was explained that FAO has three major programmes in aquaculture: the Regular Programme, the Field Programme, and the Investment Centre Programme. It was also explained that the Regular Programme supports activities implemented at Headquarters as well as through the various advisory regional bodies; while the Investment Centre Programme provides assistance to the member countries by identifying, preparing and evaluating investment projects to be financed by the World Bank, IFAD, and Regional Investment Banks.

The Field Programme as the name indicates includes the programmes and projects that FAO, as an executing agency, implements in the various member countries. Our programmes and projects are of varying duration, from months or weeks to several years, as well as of varying nature in terms of subject matters. During the course of the last thirty years that FAO has been involved in the aquaculture field programme, at least two hundred projects have been implemented (it is difficult to get the exact number as the records from

our library and registry files are periodically sent to the central archives).

Field programmes and projects are designed in consultation with the recipient countries and the donors, executed with technical backstopping and supervision from the FAO Headquarters, and periodically evaluated. Request for project design originates from public institutions in member countries, field missions of FAO staff, donors, ongoing or recently completed programmes/projects, as well as from the regional offices of FAO in Accra for Africa, in Bangkok for Asia and the Pacific and in Santiago de Chile and Port of Spain (Trinidad) for Latin America and the Caribbean.

At FAO Headquarters, the Inland Water Resources and Aquaculture Service (FIRI) is involved in aquaculture project design as well as in the technical supervision of aquaculture projects. Dr. R. Welcomme is Service Chief and is supported by eleven professionals and one Associate Professional Officer, with expertise in various fields.

The Fisheries Operations Service (FIO) of the Fisheries Department is responsible for the day to day operation of the projects and for all the administrative work involved. The FIO has the final responsibility for the outcome of the field programmes and projects. For operational purposes, FIO is organized in four regional groups viz. Africa, Asia, the Near East, and Latin America and the Caribbean. FIO is supported by outposted Personnel Officers in charge of recruitment and personnel matters and by an administrative group which takes care of finance, travel etc. At the field level, the project management is assisted by the office of the FAO Representative in the country.

The evaluation of completed field projects is carried out by an Evaluation Service (PBEE), a unit at FAO Headquarters. However, interim evaluations are carried out jointly by the technical unit and operations unit of the FAO Headquarters, the donor and the recipient country.

The housing of aquaculture in the Inland Waters Resources and Aquaculture Service (FIRI) of the Fisheries Resources and Environment Division (FIR) dates back from the sixties when the field of aquaculture was dominated by biologists. In recent days, although the main aquaculture unit remains still in FIR, there are other units such as Fisheries Policy and Planning and the Fisheries Industries Divisions within the Fisheries Department which assist in the design and supervision of field projects.

Aquaculture field programme includes both programmes and projects. The programmes, (such as the Bay of Bengal Programme), are integrated by projects which bear a logical relation amongst themselves or which are subcomponents of a very broad development objective. They usually tend to include regional activities. All our projects and programme deal with governmental institutions selected as counterparts of the FAO team of experts. Projects and programmes are financed from a variety of sources which could be external to the FAO or internal in the case of projects financed by the FAO's Technical Cooperation Programme (TCP).

In a traditional FAO project, with average life-span of 3 years, international experts are sent to the project in the host country to work closely together with the national counterparts to ensure success of the project. In short-term projects, technical assistance is provided by fielding short-term consultants to evaluate the local situation, develop a programme of work, and train counterparts through demonstration. Short-term visits by consultants are also used for reviewing project progress.

Among the external funding sources, the United Nations Development Programme (UNDP) has been the most important one, although in the recent past the Trust Funds have become an increasingly important funding source for field projects. Bilateral donors who finance field projects and programmes through Trust Fund arrangements with the FAO are the Belgian, Canadian, Dutch, French, Italian, British and Swedish Governments. Other forms of Trust Fund arrangements are with those countries which finance their own aquaculture development projects by entrusting the execution and technical assistance to FAO. The Kingdom of Saudi Arabia, the Socialist People's Libyan Arab Jamahiriya, and the Islamic Republic of Iran are good examples of this kind of project funding. Very recently, an agreement of partnership has been signed between the Commission of European Community (CEC) and the FAO under which it will also be possible for FAO to execute CEC funded projects through a special Trust Fund arrangement.

The TCP utilizes internal funds of the FAO Regular Programme for short term projects (of a maximum duration of one year) designed for solving emergency situations, bottlenecks in development process or for

identifying follow-up investment projects. The TCP can finance both national and regional projects, with a maximum funding limit of US$400,000 for a regional project.

At present the FAO Fisheries Department operates a total of 42 aquaculture projects in 25 countries (10 Asian, 6 African, 5 Latin American and 4 in the Mediterranean basin). Amongst the projects operated there are 33 which are national projects (of which 14 in Asia, 8 in Africa, 7 in Latin America and 4 in the Mediterranean), 7 regional or subregional projects (3 in Asia, 1 in the Mediterranean, 1 in Europe, 1 in Africa and 1 in Latin America) and 2 global/international projects. News from some of these projects appear regularly in the FAO Aquaculture Newsletter.

The Nineteenth Session of the Committee on Fisheries of the FAO in 1991 expressed satisfaction with the field programme of the organization and requested that the main programmes of action adopted by the 1984 World Fisheries Conference on Fisheries Management and Development be maintained beyond 1991. Action Programme Three relates to aquaculture development.

In the same year, the UNDP Governing Council at its Thirty-eighth Session (1991) decided to adopt new comprehensive arrangements regarding the involvement of UN technical agencies arose from the General Assembly resolution 44/221 on operational activities favouring national execution of UNDP funded projects has led, for the 1992-96 cycle, to a new type of arrangement with the FAO as well as with the other technical agencies of the UN system. This move, which is welcomed by the FAO as the organization has always encouraged governments to take initiatives on field project activities will, in the immediate future, result in a reduction of the number of projects directly executed by the FAO for the UNDP and will limit FAO's role to provision of technical assistance only for planning of programmes and projects and to provide specific consultancy services to projects executed by the governments of the member countries.

The on-going changes mentioned above as well as the international initiatives to rationalize assistance to aquaculture research and development have prompted the Fisheries Department to refocus its field programme. In this respect, concerns exist about development taking place without proper planning, especially with regard to environmental aspects, in such matters as conflict of interest in coastal land use, biodiversity impacts on local ecosystems due to massive introduction of new species or from massive stocking of progeny of a reduced number of genomes, effects from upstream activities on terminal ecosystems like lagoons which may make them unsuitable for aquacultural activities. In addition, the development of industrial aquaculture in several countries created concern about the environmental impact of aquaculture in those areas as well as the possible outbreak of diseases. Also, in the light of the experience gained by some of the field projects, rural aquaculture has to be reoriented as an additional activity to be integrated in rural development schemes. In this context, FAO's regional, global and international projects will try to generate new lines of work by acting as forums for specialized discussions and as executive arm for the recommendations of our regional advisory bodies. These regional activities would also assist the countries in the identification of national projects.

The involvement of the FAO in the Study in International Fisheries Research (SIFR) by organizing a series of consultations where the member countries will have the opportunity to indicate their priorities for development and research in aquaculture should also lead to the establishment of specialized network arrangements and specific projects, in which both developed and developing countries with common interest would be able to participate.

The FAO will surely continue to support aquaculture development in the member countries. In the future it is expected that the capacity of the FAO which can count not only on the expertise of the Fisheries Department but also on that of other technical departments of the organization, will be more fully utilized for national planning for aquaculture development, for the identification of technical projects to resolve development bottlenecks, for the opening up of new areas for aquaculture production, for the transfer of expertise and for the promotion of investment for a sustainable development.

PUBLICATIONS

Kumar, D. Fish culture in undrainable ponds. A manual for extension.
FAO Fisheries Technical Paper (325), Rome, FAO. 1992. 239 p.

This manual deals with the methods of freshwater fish culture in undrainable ponds as practised in India. The manual is primarily meant for extension workers and aquaculture training institutions. It outlines the basic principles of fish culture and the characteristics of undrainable ponds. The systems of composite carp culture and composite carp culture-livestock farming have been described. Methods of improvement of existing ponds and construction of new ponds have been included. The suitable species for culture, procurement of their seed, stocking, including ratios of vrious species under composite culture, etc., have been discussed. Pond management, both pre-stocking and post-stocking, including fish health management and management of common hazards have been dealt with. It also contains information on marketing and economics of fish culture in undrainable ponds.

Tacon, A.G.J. Nutritional fish pathology. Morphological signs of nutrient deficiency and toxicity in farmed fish.
FAO Fish Technical Paper (330), Rome, FAO. 1992. 72 p.

The paper summarizes the major nutritional pathologies which have been reported in farmed fish. Morphological signs of nutrient deficiency and toxicity are presented and discussed under the following headings, 1. disorders in protein, lipid, mineral and vitamin nutrition, 2. endogenous anti-nutritional factors present in plant foodstuffs, and 3. adventitious toxic factors present in foodstuffs.

In the FAO Training Series the volume 16/2 is now available in French.
Coche, A. G. Pisciculture continentale. La topographie: Levés topographiques.
Collection FAO: Formation (16/2), Rome, FAO. 1992. 261 p.

Barg, U.C. Guidelines for the promotion of environmental management of coastal aquaculture development (based on a review of selected experiences and concepts).
FAO Fisheries Technical Paper (328), Rome, FAO. 1992. 122 p.

This document is directed to aquaculture development specialists, coastal resource use planners and government officials involved and interested in the planning and management of coastal aquaculture development within the wider context of resource use in coastal areas. It is intended to serve in the promotion of environmental management of coastal aquaculture. Guidelines are given for improved environmental management of coastal aquaculture based on an overview of selected published experiences and concepts. Potential adverse environmental effects of and on coastal aquaculture practices are addressed with consideration of main socio-economic and bio-physical factors. Methodologies are presented for the assessment and monitoring of environmental hazards and impacts of coastal aquaculture. Selected environmental management options are described for application both at policy-level and farm level.

Coche, A.G. and Muir, J.F. Pond construction for freshwater fish culture - Pond-farm structures and layouts.
FAO Training Series (20/2), Rome, FAO. 1992. 214 p.

This is the fourth manual (comprised of two volumes, 20/1 and 20/2) in the **FAO Training series** on simple methods for aquaculture. It deals with the practical aspects of civil engineering related to freshwater fish culture. In the previous volume, you have learned about the general features of earthen ponds and fish farms, how to select their location, how to use building materials and equipment, how to prepare the construction site and how to build various types of ponds. In this volume, you will learn how to protect your farm against flooding and siltation. Finally, you will learn how best to plan the construction of your small fish farm.

Williams, C. Simple economics and bookkeeping for fish farmers.
FAO Training Series (19), Rome, FAO. 1992. 96 p.

This manual in the **FAO Training Series** sets out a simple outline of practical economics relevant to the lives of small fish farmers. Methods of designing simple bookkeeping forms and of analysing the recorded information are also included. This publication is primarily meant for aquaculture extension/training workers who are expected to assist small fish farmers in designing and maintaining appropriate record-keeping formats.

Review of the state of world fishery resources. Part 2. Inland fisheries and aquaculture.
FAO Fisheries Circular (710) (Rev.8), Part 2. Rome, FAO, 1992. 26 p.

This paper analyses the status and trends of aquaculture and inland fisheries in the various continental areas of the world from 1984 to 1990. Capture fisheries have remained static or even declined during this period throughout much of the world. Both inland and coastal aquaculture have shown continuous growth over the same period although the culture of aquatic plants has declined somewhat.

Lu, X. List of Inland Fisheries and Aquaculture specialists in the Indo-Pacific Region.
FAO Fisheries Circular (796) (Rev.1), Rome, FAO 1993, 119 p.

The names compiled in this updated list are those of personnel presently active in the fields of inland fisheries, freshwater and brackishwater aquaculture in countries of the Indo-Pacific region that are provided by the following countries: Australia, Bangladesh, China, India Indonesia, Malaysia, Myanmar, Nepal, New Zealand, Papua New Guinea, Philippines, Sri Lanka, Thailand, Turkey and Viet Nam. The list continues to be organized under individual countries and arranged alphabetically. A subject list is included. The list represents the second issue of this kind on a regional basis.

FAO Fishery Information, Data and Statistics Service Aquaculture Production 1984-1990.
FAO Fisheries Circular (815) (Rev. 4), Rome, FAO. 1992. 206 p.

This document contains statistics of production by aquaculture of fish, crustaceans, molluscs and aquatic plants. Statistics are given of production of species by country, by country by species, by species by environment, and value data by country.

Tacon, A.G.J. The food and feeding of farmed fish and shrimp. An annotated selection of FAO field documents, 1973-1991.
FAO Fisheries Circular (849), Rome, FAO. 1992. 92 p.

The document presents an annotated list of 326 selected FAO field reports concerned with or containing relevant information on, the food and feeding of farmed fish and shrimp, including pond fertilization through direct or livestock integration, live food production, and artificial diet feeding. The reports presented were produced during the activities of 68 FAO field projects between 1973 and 1991. Reports are listed by project for individual countries or by region. Author, country and genera indexes are provided.

Lu, X. Fishery management approaches in small reservoirs in China.
FAO Fisheries Circular (854), Rome, FAO. 1992. 69p.

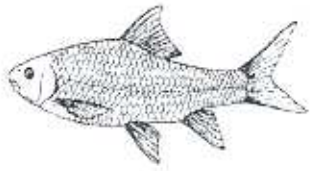
The construction of reservoirs in the People's Republic of China has created more than 82 000 man-made waterbodies which have increased the inland surface water area by more than 2 million ha. The utilization of these newly established waterbodies for the development of culture-based fisheries has been demonstrated as a means of providing animal protein, employment and income for the rural population.
This document provides an insight to some major reservoir fisheries development approaches presently being practised in China. It is divided into two parts, the first includes an overall description of reservoir fisheries in China and the various approaches presently being applied. In the second part, three case studies show three fishery management strategies; i.e., (i) a combination of cove and cage culture of fingerlings and table-fish in a reservoir in central China; (ii) integrated fish culture of fish, livestock, poultry and agriculture in a group of small reservoirs in southeast China; and (iii) application of inorganic fertilizers to enhance fish yields in small reservoirs in northwest China.

FAO NEWS ITEMS

In Bangladesh, the umbrella project "Institutional Strengthening in the Fisheries Sector" BGD/87/045, started in may 1989 and is scheduled to be terminated in April 1993, has identified the institutional problems and constraints within the Department of Fisheries (DoF) and has proposed a new structure for DoF, based on its mandates and functions. In addition, the project has strengthened the capacity of the DoF in the fields of sectoral planning, monitoring and evaluation, human resource planning and development, fish culture, and fish culture extension.

The fish culture extension activities of the project deserve special mention because of the impact it has created through the application of the extension methodology called "Trickle Down System" (TDS). The project has developed the appropriate pond fish culture technology for rural Bangladesh and has successfully transferred it to about 500 Result Demonstration Fish Farmers (RDFF) and 3700 Fellow Fish Farmers (FFF).

The TDS is based upon a very close working relationship between the extension worker and the RDFFs and FFFs. The system ensures practical, hand-on training of the RDFFs in their own ponds by the extension officers. The RDFFs in turn train the FFFs through demonstration of the fish culture technology being carried out in their ponds. After receiving training through one production cycle the FFFs graduate to RDFFs. Thus the technology trickles down from the



extension officers to RDFFs and ultimately to the FFFs and the process continues.

An important aspect of the TDS is that it encourages participation of the women and children of the fish farmer's family in the day to day management of a fish pond.

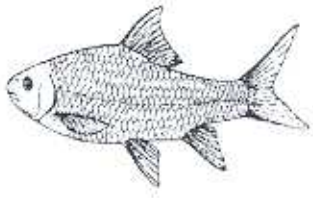
The technology adopted is appropriate in that it is technically feasible, economically viable and socially acceptable. All the needed inputs are locally available and the basic technology is flexible, and it can be tailored according to the needs and the ability of the individual farmer. Because the adopted technology is appropriate, it is expected to have a high degree of sustainability.

Following this technology the fish farmers have increased their average production from 1t/ha/yr. to 4/ha/yr., using their own resources and without any material input or credit support from the government or the project. Based on this success story the government is now seeking donor support to expand fish culture extension services throughout the country.

[FAO, Fisheries Department, Rome, (BGD/87/045)]

In Bangladesh, the project "Assistance to the Fisheries Research Institute" - BGD/89/012/01/A/12 has started operation in mid-1992. This 2 year project represents the second phase of UNDP/FAO technical assistance to the Fisheries Research Institute (FRI). FRI has four research facilities of which the Freshwater Research Station (FRI Headquarters) in Mymensingh is operational; the Riverine Research Station in Chandpur needs further improvement; the Marine Fisheries and Technology Research Station at Cox Bazar needs some additional facilities; and the Brakishwater Fisheries Research Station at Paikgacha is under construction. The project is designed to establish an effective organizational framework for FIR, formulate a core research programme with long-term relevance to the development plan of the fisheries sector, and develop a high degree of technical and management capability for research planning, implementation and coordination.

[FAO, Fisheries Department, Rome, (BGD/89/012/01/A/12)]

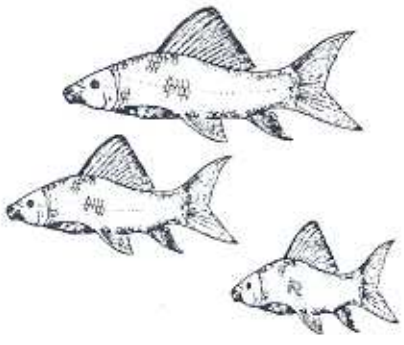


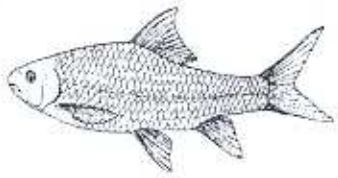
In Venezuela, the TCP (Technical Cooperation Programme) project "Institutional Strengthening of the Fisheries Sector" (TCP/VEN/0151) will be completed in the near future. The project, inter alia, has a component in aquaculture.

The project analysed a proposal for a new institutional set up in response to the new scenario prevailing in most developing countries i.e. decreasing intervention by Governments, and increasing privatization and politic-administrative decentralization. Some important issues referred to are the land planning, institutional competence regarding enforcement of regulations, the need for an information system encompassing economic trends, and the criteria to promote aquaculture through joint efforts of public and private sector.

The project has paid special attention to some specific areas such as the importance of ensuring steady, controlled growth of the shrimp industry and the recent legalization of Tilapia introduction and its culture.

[FAO, Fisheries Department, Rome (TCP/VEN/0151)]





In response to a request from the Government of Myanmar, Dr. T. Matsusato, Fishery Resources Officer, visited that country in November 1992 with a view to assisting the local experts in combating disease problems in fish and prawn hatcheries. Preliminary investigations revealed that mass mortalities of prawn larvae/juveniles were caused by black spot disease and muscle necrosis. Disease problems were also causing mass mortalities in many fish hatcheries. Dr. Matsusato prescribed preventive and curative measures and recommended for strengthening the country's fish health management capacity through a project specially designed for this purpose.

[FAO, Fisheries Department, Rome]

FAO project "Global Fish Disease Information Exchange and Diagnosis Services" (GCP/INT/526/JPN) conducted a Regional workshop on the diagnosis of Salmonid Fish Diseases in Coyhaique, Chile, from 23 November to 5 December 1992. Twenty six participants from 8 countries of the region attended the workshop. The workshop recommended that:

- exchange of information on salmonid fish diseases in the region be promoted;
- the Shiraishi's Memorial Hatchery (Instituto de Fomento Pesquero) in Coyhaique should function as salmonid fish disease data centre in South America, with reference institutes in each country;
- similar regional workshops should be held every two years, if possible.

The participants also stressed the needs for similar regional workshops on disease diagnosis of shrimps, warm-water food fish and ornamental fish.

[FAO, Fisheries Department, Rome, (GCP/INT/526/JPN)]

MEETINGS

The European Inland Fisheries Advisory Commission (EIFAC) is organizing a workshop on "Methodology for Determination of Nutrient Requirements in Fish", which will be held from 29.6.93 to 1.7.93 in Eichenau, Germany. The Workshop will have the following objectives:

- to collate existing data on nutrient requirements and recommended nutrient levels in diets for economically important finfish species and to identify gaps.
- to compare methods for the determination of requirements and to recommend guidelines to be adopted and to specify further research needs.
- to evaluate the existing methodological approaches for the determination of nutrient needs of fish within semi-intensive pond farming systems.

Further information on this workshop can be obtained from Prof. Jürgen Gropp, Institut für Ernährungsphysiologie, Veterinärstraße 13, 8000 München 22, Germany, Fax: 089-344937.

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