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EDITORIAL

Integrated Rice-fish Culture

Culturing fish in rice fields. This production system can be classified into two categories. In the **rotational system** *fish (fish/crustaceans) are cultured in the rice fields in between rice crops. Being cultured separately, there is no or very little negative impacts of one over the other. It allows deeper water in the rice fields and results in higher production of fish per unit area. The residues from fish culture makes the soil richer for rice culture; and the residues from the rice culture, such as rice stubs, encourages growth of fish food. Fish production under this system varies from 300-600 kg/ha/yr. Under the* **concurrent system**, *rice and fish are cultured together in the same field. Fish production under this system is much smaller, varies from 100-300 kg/ha/yr. The advantages of this system are that (i) it enriches the soil and thus help increase rice production by about 10%, and that (ii) it controls insect pests, including mosquitoes and aquatic weeds.*

At present approximately 1.5 million ha of irrigated rice fields, with water depth of less than 50 cm, are under fish culture and are producing an estimated 150, 000 t of fish. However, since the sixties, rice-fish culture practices are steadily declining mainly because of the facts that high yielding rice varieties require less water, but higher amounts of fertilizer and pesticides; thus making the irrigated rice field environment unsuitable for fish *culture. Therefore, the prospect of increasing fish production from the irrigated rice field is not very promising.*

Fish culture has not yet been integrated with Deep Water Rice (DWR) culture. The DWR is defined as rice varieties that grow in water depths of over 50 cm. These varieties of rice remain flooded for 4-5 months, usually in monsoon seasons in south and south-east Asian countries. Out of a total of about 9 million ha of DWR, 8.5 million ha are found in Asia. India and Bangladesh each has nearly 2.5 million ha of DWR. The DWR fields have the sufficient depth of water for fish culture for at least 4 months, and unlike the irrigated rice fields they are not exposed to the negative impacts of fertilizers and pesticides. If only 10 % of the DWR fields were integrated with fish culture, yielding an average fish production of only 200 kg/ha/yr, an estimated 200, 000 t of fish could be produced.

Very little information on the DWR ecosystem is available. Preliminary investigations show that it usually contains a rich flora and fauna and is rich in fish food. At this point in time, we do not have the appropriate technology for the integrated culture of DWR and fish. However, considering its potential socio-economic benefits, the national governments and donor agencies should allocate resources for Research and Development projects to explore this avenue.

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NATIONAL AGRICULTURAL FEED SURVEYS (NAFS) FOR AQUACULTURE PLANNING AND DEVELOPMENT "GUIDELINES"

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INTRODUCTION

If world finfish and crustacean aquaculture production is to maintain a modest growth rate of 5% per year into the next millennium then substantial inputs of fertilizer and feed will have to be provided. For example, around 1-2 kg of pelleted aquafeed (ca. 25% protein), 3-6 kg of dry cereals, 3-8 kg of dried animal manure or 20-30 kg of green fodder are required as feed or fertilizer inputs to produce 1 kg of warmwater omnivorous finfish within semi-intensive pond-based farming systems. Similarly, about 1-2 kg of pelleted aquafeed (ca. 50% protein) or 3.5-5 kg of fresh fish are required as feed inputs to produce 1 kg of marine carnivorous finfish within clear-water intensive farming systems. In view of these high nutrient inputs it is perhaps not surprising therefore that food and feeding usually represents the largest single operating cost item of most intensive and semi-intensive farming operations.

However, if the aquaculture sector is to meet it's demand for fertilizers and feeds it will have to compete with the traditional livestock production sector and with humans for available agricultural resources; the large majority of agricultural products used as pond fertilizers or within compound aquafeeds also being used as crop fertilizers (i.e. chemical fertilizers and organic manures), within livestock feeds (i.e. fish meal, fish oil, animal by-product meals, oilseeds, cereals, fodder etc.) or used for human consumption (i.e. fish, fish oil, oilseeds, cereals, root crops, vegetables etc.). Although the aquaculture sector has been successful in the past in obtaining the necessary fertilizer and feed inputs (compound aquafeed production in 1993 is expected to be only about 3% of total world compound animal feed production), this may not be the case in the future as farming systems intensify and the demand for a finite pool of agricultural resources increases.

At present little or no practical information exists concerning the available fertilizer and feed resources of most developing countries; the large majority of published information being in the form of non-annotated numerical production data within a myriad of different government annual reports. Clearly, this situation will have to be improved if the resident aquaculture sector is to make maximum use of locally available agricultural resources and so reduce it's dependence upon imported feed ingredients and compound aquafeeds. This paper aims to provide some general guidelines for conducting a National Agricultural Feed Survey (NAFS) so as to enable the aquaculture producer, public or private, to develop his or her own national aquaculture feeding strategy.

OBJECTIVES OF NAFS

The objective of NAFS is the compilation and publication of agricultural feed ingredient directories for all member countries which could subsequently be used by the public and private sector for developing national aquaculture feeding strategies. Presented in the form of an illustrated atlas, the country directory would contain information on the fertilizer and feed resources of the country especially on where they are geographically located, how much is available and when, who is currently using this resource and how, the composition and cost of this resource at source and with transportation, together with an assessment of the status of the existing animal feed manufacturing industry and its regulations. The guidelines for conducting a national agricultural feed survey are contained in Tacon, Maciocci & Vinatea (1987) and they are summarized below:

NAFS GUIDELINES

Background information - country profile

An essential component of NAFS is the collection of baseline data on the social, cultural and political environment within the country, together with basic information on the status of the existing agriculture and aquaculture sectors. This background information will enable the user to form an overall picture or profile of the environment in which he or she operates, and will help to identify the economic, cultural and environmental constraints which will indirectly or directly affect the choice of feeding strategy.

Demography and the general economy

The information required can be presented in the form of two Tables, one concerning human resources and economic data, and the other concerning commodities and services (i.e. electricity, gas, water, freight, transportation) price index. For certain information (i.e. population density, major cities, transport and communications, ethnic/language groups, land and water use) the data can be presented in map form, whereas the major economic indicators (i.e. balance of payments, growth of domestic product, money supply, wages, prices, inflation, total external debt, unemployment rate, and value of exports or imports) can be presented graphically as trends.

Agriculture and food policy

The major agriculture sectors operating within the country (i.e. rural/small-holder/large-holder) should be briefly described, including historical development (if appropriate), geographical location (map), major food items produced (crops and livestock), area farmed, role in the economy, and labour inputs. In addition, the national agriculture and food policy should be described, indicating government priorities and development plans, together with financial incentives and constraints (i.e. credit lines, subsidies, and import/export taxes and exemptions). Finally, information should be collected on the nutritional habits or food supply of the population and presented as a table.

Fisheries and aquaculture

The status of the capture fishery (marine and freshwater) should be described; including historical development, geographical location of the industry (map), major fishery products produced, role in the economy, employment, utilization of the catch, commodity and trade balance, development prospects, government policy and development plan, and financing and fiscal facilities (i.e. credit lines, subsidies, import/export taxes/exemptions).

Finally, so as to complete the background information, the aquaculture sector (public and private) will also have to be described, including historical development (i.e. farming tradition), major indigenous and imported cultured species, annual production, farming intensity (intensive/semi-intensive/extensive), geographical location of the major farms (map), feeding strategy employed (fertilization/supplementary feeding/complete diet feeding), production unit (lagoon/pen enclosure/cage/raceway/tank/pond), labour input (full-time/part-time), investment and economic viability (if known). Information should also be collected on the national aquaculture policy, including priorities, financial incentives, and support services (seed supply, disease diagnosis, research, training, and information).

Agricultural feed survey

National fertilizer and feed resources

The information required should be presented in statistical form as shown in Box 1. The geographical source of the major fertilizer and feed resources should be presented in map form as shown in Box 2.

Animal feed manufacturing industry

The status of the animal feed manufacturing industry operating in the country should be analysed as shown in Box 3.

Finally, a directory should be compiled of all the animal feed manufacturers and agricultural suppliers /support agencies within the country; including national agricultural associations, agricultural suppliers (grains, oilseeds, fertilizers), abattoirs, feed milling companies, and other feed/food processors such as bakeries, breweries, canneries, sugar mills, etc.

Presentation and interpretation of the NAFS report

The NAFS report should be presented in the form of an illustrated atlas of national fertilizer and feed resources, with text being restricted to the analysis of agriculture policies, development plans, farming traditions, and the social and economic climate of the country. Although the physical task of collecting the resource data may appear daunting, the information can be readily abstracted from government agricultural statistical reports, national and regional development banks, national geographic institutes, international support agencies, and through field visits and questionnaires.

To date, national agricultural feed surveys have been conducted for Papua New Guinea (Tacon, 1986), Peru (García Carbajal & Rodríguez Achung, 1989), Panama (Licona de Macedo, González de Paniza & Sánchez, 1989) and Mexico (Palomo & Arriaga, 1988).

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Box 1: National food, feed and fertilizer resources 1/

Primary foods

Crops
- Cereals
- Roots and tubers
- Sugars
- Pulses
- Nuts and oilseeds
- Vegetables
- Fruit

Data required: Source (map); Area harvested (ha)
Production (tonnes/year, t/y)
Exports (t/y); Imports (t/y)
Total domestic supply (t/y)
Domestic utilization (% feed, seed, manufacture, food, waste)

Livestock
- Beef cattle
- Dairy cattle
- Pig
- Chicken
- Sheep
- Duck
- Other

Data required: Source (map); Stocks (head, h)
Slaughtered (h/y); Carcass weight (kg)
Production (t/y); Exports (t/y); Imports (t/y)
Total domestic supply (t/y)

Secondary foods and by-products

Vegetable
- Crops
- Food industry
- Non-food industry
- Aquatic plants

Livestock
- Feed meals
- Fats
- Offals
- Manures

Fish and seafood
- Feed meals
- Oils
- Offals

Miscellaneous animals
- Invertebrates
- Livefood organisms

Data required: Source (map); Production (t/y)
Imports (t/y); Utilization (% export, feed, fertilizer, fuel, waste)
Cost at source (local currency units/t, Lcu/t)

Feed additives
- Amino acids
- Vitamins
- Minerals
- Binders
- Pigments
- Stabilizers
- Growth promotants

Data required: Source (map); Production (t/y)
Exports (t/y); Imports (t/y)
Total domestic supply (t/y)
Utilization (% food, feed)
Cost at source (Lcu/t)

Chemical Fertilizers
- Nitrogenous
- Phosphate
- Potash
- Mixed and complex

Data required: Source (map); Production (t/y)
Exports (t/y) ; Imports (t/y)
Total domestic supply (t/y)
Cost at source (Lcu/t)

Composition of fertilizers and feeds

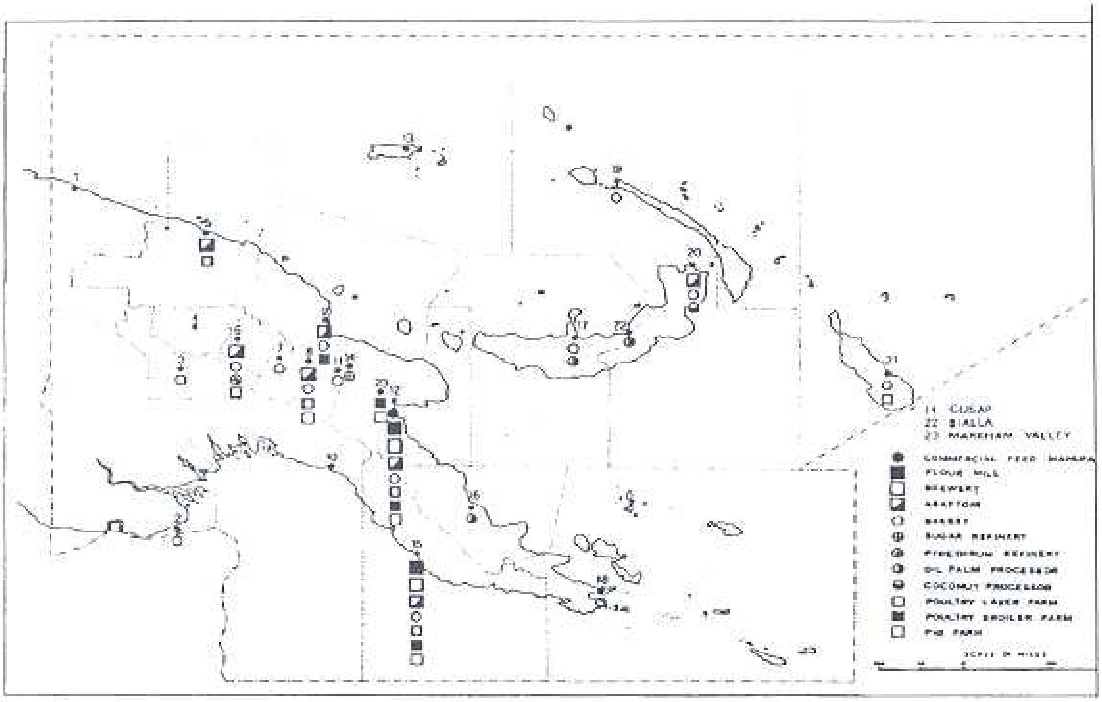
Proximate chemical composition

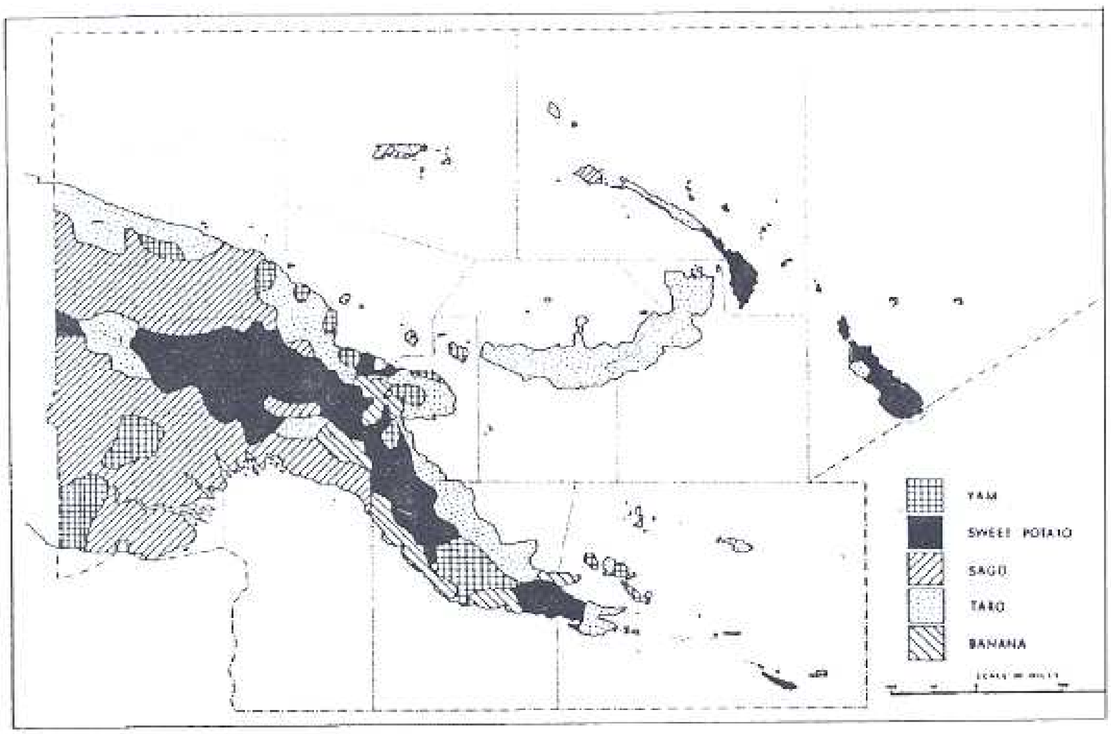
Seasonal availability (farming calendar)

1/ the information contained within this Table should be obtained for all the major food, feed and fertilizer items available in the country

Box 2: Proposed format for displaying the geographical source of feed or fertilizer resources

Example shown is for an agricultural feed survey in Papua New Guinea (Tacon, 1986)





Box 3: Status of the animal feed manufacturing industry

Background information

- History/general description
- Geographical location (map)

Production

- Total compound/concentrate feed production (t/y; annual growth rate; imports t/y)
  - Poultry
    - Layer
    - Broiler
  - Pig
  - Calf
  - Dairy cow
  - Duck
  - Horse
  - Rabbit
  - Pet food
  - Fish/crustaceans (% breakdown by species)

Major feed manufacturers

- Mill 1
- Mill 2
- Mill 3 ... etc

Cooperatives

Data required: Location; Major share holders; Start of operations; Annual feed production (including mill production capacity, shifts, plant type); Major feed lines produced (% of production); Imported feed ingredients used (including cost and composition); National feed ingredients used (cost and composition); Average diet cost and composition; Quality control facilities

Distribution and marketing

- Network
- Sales conditions
  - Minimum order
  - Lead time on orders
  - Payment facilities
- Transport
  - Means and cost

National feed manufacturing regulations

- Quality control
- Mixing
- Grinding
- Packaging
- Labelling
- Contaminants
- Imports

Prospects, trends and constraints

- Demand
- Ingredient and feed subsidies
- Taxes

FISH HEALTH MANAGEMENT FOR SUSTAINABLE DEVELOPMENT OF AQUACULTURE

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Introduction

How many aquaculture systems have survived more than two hundred years of operation? There are very few aquaculture practices with long history. For example, the most notable ones are oyster, carp and trout culture in Europe; Chinese carp culture in China; and oyster, carp and seaweed culture in Japan. With the exception of trout culture in Europe, all of them are of extensive culture system. To fully understand the concept of sustainable aquaculture one should visit aquaculture sites such as oyster culture areas in Southern France; the agriculture-livestock-carp integrated cultures of Southern China; the culture ponds (several hundred hectares, the size of small lakes) in South Bohemia, Czech Republic; or the seaweed culture fields on the southwest coast of Japan. I remember accompanying some American scientists to visit Ariake Bay, the largest seaweed field in Japan. At first they saw nothing but the bright, glittering surface of the sea; after a couple of hours, at ebb-tide, they saw thousands and thousands of bamboo poles sticking out of the water; and two hours later they were able to appreciate the "seaweed fields", when more than 20 million culture nets covering roughly 240 km^2 became visible.

Lessons from the past

Why did carp and trout culture systems survive for so long? Let's examine first trout culture in Europe, as this constitutes an excellent example of long-lived, intensive culture of a carnivorous fish species. Originally, trout culture in Europe was termed "spring trout culture", as pathogen-free, transparent, low temperature ground-water of adequate and stable quality was used. Most importantly, from an epizootic viewpoint, trout farms were sparse ensuring pathogen-free eggs and juveniles. One can still see this at Snake River Valley in the U.S, where trout farms use pristine spring or well water which flows through the ponds for once only. I suppose that most aquaculturists cherish this notion of disease free aquaculture. In fact, clean water and pathogen-free seeds and equipment are the main factors which ensure disease prevention in aquatic organisms.

In recent years, Atlantic salmon cultures in north-western Europe (Norway and Scotland) have been exposed to many new parasitic and bacterial diseases. Chemotherapy and treatment with DDVP (Dimethyl-dichlorovinyl-Phosphate), garlic, onion or pyrethrum for controlling sealice infections of Atlantic salmon in farms in Scotland have proved ineffective. Similar problems, induced by external vectors such as parasites with a simple life cycle, have been occurring in Asian intensive mariculture systems, exemplified by the monogenetic trematode parasitic diseases of yellow-tail, *Seriola* spp. and the *Isopoda* infection of sea bream and sea bass. In Norwegian salmon farms, many environmental problems have been cropping up recently. For example, pollution of the sea floor of the culture fields, nutrient enrichment and low oxygen level in the farm waters, appearance of an increasing number of drug-resistant strains of pathogenic bacteria, and mass mortalities induced by red tides, are causing problems to Norwegian Salmon farms. The Japanese intensive marine fish cultures have also suffered from similar problems.

As for carp culture, the record of longevity is held by China. The oldest textbook on fish culture, the "Fan Li's book on Pisciculture", was written in the fifth century B.C. Fan Li mentioned in his book, among other things, about the sex ratios to be followed among the carp spawners and the detailed structure of a culture pond. In addition, he suggested the use of soft-shell turtles in the culture pond, presumably for ecological control of diseases. In general, Fan Li's principles of carp culture are still recognized as valid and applicable. The soft-shell turtles are nowadays being substituted by some carnivorous species of fish such as catfish or pike. In China, complex eco-production systems like the silk worm-fruit tree-fish-livestock-vegetable culture systems have been operating successfully for over one thousand years, based on Fan Li's precepts. These systems not only integrate fish culture with agriculture and animal husbandry but also involve stocking the same pond with species of fish with different feeding-behaviour such as benthos feeders, phytoplankton feeders, zooplankton feeders and grass feeders, and rearing them in perfect equilibrium within a complex ecosystem.

With regard to oyster and seaweed cultures, it may be said that these cultures are in harmony with their environment and that their productivity depends upon natural productivity of their micro- and macro-environments. These cultures therefore are bound to last for a very long time, their life-span depending on the natural conditions of the culture fields. Most of the diseases affecting oysters and seaweeds are caused by unsuitable environmental conditions such as polluted seabed, high water temperature, heavy rainfall, etc., and by high stocking density. Hence, it can be concluded that in order to achieve sustainable aquaculture and sound fish-health management, one must maintain seed and water pathogen-free, create a balanced ecosystem, resort to ecological disease-control techniques and pay due attention to the carrying capacity of the system.

Pattern of Development of Sustainable Aquaculture

When one examines the history of long-lived culture systems of carp, seaweed and oyster, the similarities in their pattern of development become very clear. At the beginning, there were no or very little troubles with the culture systems and production increased steadily year after year. After this lucky period, most farmers were faced with fluctuations in the survival rate or variations in the growth rate of individuals of the target species. Subsequently, some simple disease problems appeared. When these problems were surmounted, happy spells were enjoyed, resulting in an expansion of the farming activities. During this period the number of farms increased, resulting in shortages in quality water supply and suitable culture sites. With the development of new techniques the critical technical problems were resolved and the culture systems expanded further. These culture systems next faced economic problems such as low market price due to overproduction, increased production costs, etc; and when these problems were brought under control, the culture systems reached a regulated national/global production level, attaining an economic balance. Culture systems recently developed, such as *Penaeid* shrimp culture, is still in the "initial phase", technically speaking, since no major technical break-through has been achieved in controlling or minimizing pollution problems in shrimp culture ponds. As a consequence, most shrimp farms had to accept a drop in their productivity year after year. With intensive culture of kuruma shrimp, *Penaeus japonicus* in marine waters, the expected lifespan of a pond is 2-3 years. With intensive cultures of *Penaeus monodon* in tropical brackish waters, the same pond could be used for 2-3 years with no trouble, but after that the production level is expected to fall. The lifespan of shrimp culture ponds depends on the stocking density, food and feeding, quality of the bottom soil and water temperature. In general, most intensive shrimp culture ponds can only be used for one or two years. After this period, a lot of problems arise, ultimately causing a drop in the productivity of ponds. In such cases, diseases are the visible indicators of the deteriorating situation.

Technical Problems of Fish Health Management

If diseases of cultured aquatic animals are a measure of the inadequacies of certain culture techniques, a correct diagnosis is essential for forestalling the ensuing problems. We have some understanding of about one hundred basic fish diseases and new diseases are being discovered every year. The difficulties in the diagnosis of diseases of aquatic organisms are due to -

- too many host species (the number of main aquaculture target species is approximately 200 and is increasing every year);
- insufficient basic knowledge of the disciplines (biology, pathology, physiology, histology, immunology, etc.) involved;
- lack of a practical methodology for the diagnosis of diseases of aquatic organisms;
- lack of a theoretical background of the pathology of aquatic organisms;

- lack of basic knowledge of pharmacology of aquatic animals; and
- shortage of trained manpower at all levels of operations and lack of adequate laboratory facilities.

In the light of the above discussion, we need to develop an effective methodology for fish health management. Such a methodology should have two phases viz. initial diagnosis and final diagnosis. For initial diagnosis, the field diagnosticians should have enough general knowledge of biology and ecology, and good practical experience in hatchery and culture operations. Initial diagnosis, essentially a symptomatic examination, should be carried out at the site, mainly by collecting information through visual investigations and field analyses of samples. Final diagnosis should be carried out by specialists (parasitologists, bacteriologists, virologists, histopathologists) through detailed analysis of samples collected during initial diagnosis. Based on the results of the investigations, the field diagnosticians should then recommend treatment and a management programme for the fish farmers.

Three important constraints related to fish health management and the development of a sustainable aquaculture system, emerge from the above discussion. The first constraint is that most of the present aquaculture systems lack self-sustainable techniques such as ecological disease control methods and maintenance of a balanced ecosystem as practised in carp polyculture, oyster culture and seaweed culture. The second constraint is that achieving a real technical break-through is difficult, costly and time consuming. And, the third constraint is that there is a real shortage of expertise in the field of fish health management. Concerted efforts should therefore be made to resolve the above mentioned constraints before we could hope to develop aquaculture systems that would be sustainable in the truest sense.

UTILIZATION AND CONSERVATION OF AQUATIC GENETIC RESOURCES - DEVELOPING GUIDELINES

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From November 9 - 13, 1992, the Inland Water Resources and Aquaculture Service (FIRI) held an Expert Consultation on Utilization and Conservation of Aquatic Genetic Resources, in Grottaferrata, Italy. Experts from 19 countries and the International Centre for Living Aquatic Resources Management (ICLARM) were joined by professionals from FAO and the University of Rome to advise FAO Member Countries and the international community on the management of genetic resources of aquatic animals. In this respect, the Consultation sought to build on past experiences of the genetic programmes of FAO and elsewhere, and to integrate its recommendations within the framework of the United Nations Conference on Environment and Development (UNCED). A synopsis and highlights of the Consultation follow below.

Background

In the light of recent international conventions and action plans, particularly the Convention on Biodiversity and Agenda 21 from UNCED, the time is right for a strong international effort aimed at optimizing the use and conservation of aquatic gene resources. Capture fisheries in 1990 harvested approximately 85 million metric tonnes from marine, brackish, and freshwater environments. Aquaculture production for the same year was 12,135,012 metric tonnes. However, aquaculture is expected to play an increasingly important role in meeting the protein requirements of a growing human population. The wise use of genetic resources, biotechnology, intellectual property rights and patenting will play a vital role in achieving sustainable production from the aquatic environment, as well as in the protection of valuable genetic resources present in natural populations.

Aquaculture lags behind agriculture in the management of genetic resources. For example, FAO in association with the European Association of Animal Production maintains data on 83 breeds of buffalo, 622 breeds of cattle, 271 breeds of pigs, 265 breeds of goat, 636 breeds of sheep, and 274 breeds of horses. The International Rice Research Institute maintains over 80,000 accessions of rice that represent a tremendous wealth of genetic diversity. At present, the vast majority of the genetic resources of aquatic animals is found in wild populations, as very little genetic differentiation of farmed fish or domestication of aquatic animals has taken place. There are a few notable exceptions, which include strains and varieties of common carp, rainbow trout and, more recently, tilapia.

However, the potential for development of genetic resources in aquatic animals is just as great as that of terrestrial species. There are somewhere between 20,000 and 30,000 species of fishes that are adapted to environments ranging from warm tropical waters to freezing seas, from fresh waters to hyper saline lakes, and from sun bathed tidepools to near lightless caves. These species represent valuable resources that contribute to the economic, cultural, and aesthetic richness of the world and can provide the raw materials for domestication and genetic improvement of farmed fishes.

However, the genetic resources of aquatic animals are being threatened. Environmental degradation and habitat loss are causing the loss of valuable populations and threatening extinction of some species. Fishing pressure further reduces both genetic and species diversity in heavily exploited fisheries. In an effort to enhance, restore, or establish a fishery resource, species have been moved across the globe and introduced in totally new environments. Often, this unregulated movement of species has caused unexpected damage to the recipient ecosystem.

Clearly, efforts must be made to maximize the use of the genetic resources of the aquatic animals through effective conservation and management measures. It was with this background that the Expert Consultation was convened.

Over a decade ago, the first Expert Consultation on genetic resources was convened by the Fisheries Department of FAO in conjunction with UNEP. It focused on technical matters and genetic theories. In the ten years following the first consultation many advances in technology and theory of genetics have been made. However, the application of these principles and technologies to practical problems of fish farming, fishery management and conservation have been slow to materialize. Therefore, additional concerns of the present Consultation were to try to understand the reasons for the failure to utilize genetic principles and to determine how to correct the shortcomings.

The Consultation

After welcoming remarks from FAO and the University of Rome, Tor Vergata, the Secretariat designated Dr. Fred Utter as Chairman of the Consultation. The Consultation commenced with the presentations of experience and background papers, the purpose of which was to provide a common starting point for further discussions on the utilization and conservation of aquatic genetic resources. The first four experience papers represented contributions from Drs Esquinas-Alcazar, Steane, Souvannavong, and Ms Van Houtte, all FAO Officials, responsible for genetic resources of agricultural plants, livestocks, forestry, and legal aspects, respectively. These contributions served as excellent models for designing the fisheries programme. Each of these departments adopted a specific strategy to deal with the complex issues of genetic resource utilization and conservation. These strategies range in complexity from the group of experts that serve as an Advisory Body to the Forestry Department, the proposed Global Forum for Animal Genetic Resources, to the Commission on Plant Genetic Resources and the International Board for Plant Genetic Resources.

The background presentation by Fred Utter and Nils Ryman demonstrated the practicality and potential of utilizing genetic markers and genetic stock identification in mixed stock fisheries. Although much of the application of genetic stock management has concerned salmonids, these authors provided a useful review of salmonid and other data on genetic management of fisheries and outlined techniques and strategies for their use on other species in various climatological zones.

The presentation by Yuri Altukhov reviewed effects of fishing on genetic resources primarily in the former Soviet Union. This review was considered important because of the fact that documentation of the real effects of fishing activities on genetic resources are very rare. The classic effects of over fishing on a population e.g. fast juvenile growth and smaller size at age of maturity were shown to reverse themselves during the several years of fishing cessation caused by the second World War. The effects of selective fishing are difficult to predict and it was exemplified by the facts that in Russia heterozygosity at one locus was seen to increase with fishing pressure; whereas in the South Pacific, overall heterozygosity was seen to decrease.

Dr. Li Sifa's paper highlighted that China, the leader in aquaculture production, is also a country of vast genetic resources that are seriously threatened. China's natural aquatic diversity and traditional inland and marine fisheries are threatened by the need to feed the most populace nation on Earth. Strong conservation strategies were seen to be necessary in protecting China's resources so that the country would be able to maintain its lead position in aquaculture production.

Dennis Hedgecock provided a succinct survey of the advantages, current problems, and future prospects for methods to procure genetic data. The methods of genetic analyses are expanding and at an ever increasing rate. Hedgecock pointed out that funds for laboratory equipment, supplies, etc., as well as climatological zone will play key roles in designing sampling and analytical protocols. For example, to survey genetic diversity, one would focus on sub-population diversity in temperate latitudes where stocks and genetically differentiated populations are important; whereas, in the tropics sampling would concentrate on species differences.

The importance of a balanced approach to biotechnology and genetically modified organisms was stressed by Eric Hallerman and Anne Kapuscinski. New genetic technologies are exciting and have the potential to increase food production. However, Hallerman et al. pointed out that much more basic research, experimentation, and evaluation must be carried out before the wide spread use of these technologies are allowed especially in the developing world where substantial natural genetic diversity may be affected.

Brian Harvey presented one of the new technologies that does have immediate use for conservation and utilization of genetic resources, namely cryopreservation. Harvey stated that possibilities of recreating lost stocks from cryopreserved sperms are now realities and that they will figure heavily in conservation efforts and will lend justification for gene banks and other zoological collections. Combined with techniques to reverse sex in fish and to manipulate chromosomes during mitosis and meiosis, increased utilization of cryopreserved sperm in both the developed and developing world is expected.

Boyd Haight provided an informative review of aquaculture and biological diversity in southern Africa. This information is important as Africa is providing genetic resources to the rest of the world in the form of fishes that have tremendous culture value. Two prime examples are the various species of tilapia and the African catfish.

Two papers by Roger Doyle and Ambekar Eknath discussed breeding programmes, and the role and effects of selection and genetic diversity in domesticated or semi-domesticated aquaculture stocks. The diversity of approaches as outlined in these two presentations show the wide range of prospects and options available in utilizing and conserving aquatic genetic resources. Eknath reported significant gains in the culture performance of Nile tilapia after only a few generations of combined selection. Doyle approached the subject from a more theoretical angle and utilized advanced DNA fingerprinting technology and mathematical sophistication. Both approaches stressed the importance of monitoring and critical evaluation of breeding programmes. A third paper dealing with quantitative genetics, selection and changes in genetic diversity was presented by Hans Bentsen. This presentation highlighted the fact that basic research and standard usage of key terms are still needed to understand the complex relationship between genotype and phenotype. Bentsen presented a quantitative genetic model that predicted little net loss in genetic diversity even following long periods of intense selection. In light of the fact that quantitative traits are controlled by a great number of genes, a population or stock under selection for production traits may have similar phenotypes, but will have many different genotypes, with regards to the trait under selection. Therefore, Bentsen proposed that the genetic diversity is in fact maintained and when selection for the phenotype is relaxed, the genes may resegregate to produce different phenotypes.

Some of the problems aquaculturists and resource managers encounter with nomenclature concerning genetic differentiation below the species level were presented by Devin Bartley. Since the 1970's aquaculturists have requested a standard system of nomenclature. Borrowing elements of some useful and not so useful definitions that have been applied to domesticated crops and livestock, Bartley proposed one system to designate strains in aquaculture. Although several systems of nomenclature are possible, some form of standardization was felt necessary with specific application to international strain registries or databases.

John Epifanio presented some ideas on a network of fishery geneticists that generated much discussion and debate. It was clear that an information system is needed, but not clear what form this should take. The real needs are for people to get together and interact. Epifanio prepared and distributed the data sheet which is inserted in this issue of FAN. Eric Hallerman distributed the same data sheet to the members of the Genetics Section of the American Fisheries Society and we have entered 64 experts into the database. Please complete the data sheet and return it to FIRI, Fisheries Department, FAO, Rome, if you are interested in this process.

Following the formal presentations, the participants were organized into four working groups: 1) policy and regulations, chaired by Dr. Graham Gall; 2) natural populations, chaired by Dr. Valerio Sbordoni; 3) aquaculture, chaired by Dr. Gideon Hulata; and 4) fishing and fishery-related activities, chaired by Dr. David Coates. The groups were asked to provide brief overviews of the subject of their working group, to identify central issues and problems and then to establish a set of recommendations for the utilization and conservation of aquatic genetic resources.

Recommendations

The recommendations and proceedings of the Consultation will be published in the near future. Summaries of the major recommendations are as follows:

Because of the often blurred boundaries between the disciplines of aquaculture, fisheries, and natural aquatic populations, it was not surprising that many of the working groups identified similar problems and made similar recommendations with regards to genetic resource conservation and utilization. Therefore, the recommendations of the working groups were re-organized into the following categories: general concerns, natural populations, stocking and enhancement, introductions and transfers, fisheries and fishing activities, aquaculture, and policy and regulatory. Increasingly, the management of aquatic genetic resources will involve multi-disciplinary actions, the aquaculturists must be aware of the impacts of the farm on wild biota, as well as be aware of the natural genetic resources available to help increase the farm's production. Fisheries managers must be aware of the advantages and threats of stocking, introducing and transferring aquatic organisms to rehabilitate fisheries, and must take care not to disrupt natural aquatic communities and subsistence fisheries.

Some participants take a deserved break during the Consultation at Grottaferrata

The Consultation stressed that genetic principles are absolutely necessary to insure sustainable food production and a good quality of life in developing countries and rural areas. Although genetic principles are basically the same for aquatic and terrestrial organisms, aquatic resources should be considered separately from terrestrial ones, due to the unique qualities of aquatic life. For example, there are only a few domesticated fishes and most of the production comes from wild populations, the management of aquatic systems often involves common property areas while terrestrial organisms are managed on private lands, and the fluid nature of the aquatic environment connects different areas facilitating transport of organisms and pollutants.

The experts felt that generally adequate technical information and theories exist on means to utilize and conserve genetic resources, but that this information was not reaching the appropriate users. Nearly all of the working groups recommended that genetic principles and their application to fishery management and aquaculture need to be promoted through education, training, and the dissemination of easily understood, user friendly, publications.

Needs for research and further clarification were identified in the areas such as effects of fishing on genetic resources of aquatic populations, effects of long term selection for quantitative traits on genetic diversity, how genotypes are translated to phenotypes, and the definition of aquatic genetic resources. The scarcity of data on genetic resources of aquatic species, especially in developing tropical areas was acknowledged. The Consultation pointed out that knowledge will never be absolute when dealing with natural systems, but that this should not be used as a rationale for inaction. We must act now, with the best information available to conserve our resources.

The Consultation stressed the importance of conserving wild populations and also the genetic diversity of domesticated or populations in farms and hatcheries. Both the potential benefits and hazards of stock enhancement projects were presented and the Consultation recommended that due consideration should be given to the effects of hatchery produced fish on wild populations. Additionally, it was acknowledged that monitoring programmes for projects on selection, stocking, introductions, and other forms of fishery management are essential to judge the impacts of such projects.

Recommendations were also advanced for the formulation of comprehensive genetic conservation strategy, for the mobilization of support for genetic conservation, for habitat protection and rehabilitation, and for the regulation of fisheries. New technologies such as transgenic fish production, should be approached cautiously with adequate evaluation of their impacts on the local environment and of the local capability to utilize such technologies.

It was generally agreed that the current legislations, both national and international, are not sufficient to ensure effective utilization and conservation of aquatic genetic resources. Therefore, the Consultation suggested that laws, codes of practice and regulations designed specifically for this purpose, should be adopted.

Conclusion

The Consultation provided a clear direction for FAO and the international community to follow with regards to managing the genetic resources of aquatic animals. Now comes the hard part, namely promoting principles of genetic resource management and putting the recommendations into practice on a global scale. However, the rewards of following this course are worth the effort. Immediate gains in aquaculture production will be possible through comprehensive breeding programmes, hybridization projects and the responsible use of selected genetically modified organisms; improved management of both cultured and wild populations based, inter alia, on genetic resources will increase their vitality, resilience, and even profitability; the responsible use of exotic species will increase food production while ensuring adequate safeguards for native resources. In summary, it is believed that the application of these principles would help ensure a higher quality of life for the world's growing human population.

Research activities at the University of Rome Tor Vergata aquaculture facility

POND FISH CULTURE EXTENSION SERVICES

The Bangladesh Experience

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Background

The fisheries sector plays a very important role in the socio-cultural and economic life of Bangladesh. It contributes about 80% to the nation's animal protein intake, nearly 3% to the GDP and more than 12% to the export earnings. Close to 13 million people are directly or indirectly engaged in activities related to fisheries, of which about 2 million people are employed full-time and the remaining 11 million are employed part-time. The increase in fish production has not kept pace with the rate of population growth. As a result, daily per capita fish supply has fallen from 33 g to 20.5 g during the last 20 years and at present about 80% of the households are protein deficient. Even to maintain the present low level of consumption, with the present rate of population growth of 2.6% , the present fish production of 850 000 will have to be increased to over 1.2 million tons by the year 2 000.

Bangladesh has extensive water resources, both inland and marine. The inland water resources of Bangladesh is very rich. The total area of perennial waters is estimated at 1.45 million hectare while the inundated crop fields and the total low lying areas that retain monsoon water for 4-6 months is estimated at 2.83 million hectare. Inland fisheries contribute 72.5% of the total fish production of the country while the remaining 27.5% come from marine sources. Inland fisheries resources are produced mainly from three sources - impounded waters, inundated crop fields and open waters. Impounded water bodies in the form of ponds, are scattered all over the country covering an area of about 150, 000 ha.

Bangladesh is one of the most ideal place for pond fish culture. Suitable range of temperature, rich soil and water, and the presence of fast-growing local carp species make it possible for fish to grow year-round. Village ponds are integral part of the daily life of rural families. There are over 1.28 million ponds in the country. Majority of these undrainable ponds are multipurpose in use and homestead in location. Most of them were excavated for soils needed for raising the foundations of homestead above the flood level. Village pond water is used for bathing, washing, drinking, cooking, small scale agriculture and animal husbandry, and traditional fish culture. Under the traditional method of fish culture the ponds are stocked with very small fingerlings of unknown quality and quantity and are left to grow unattended. Such practices yielding an average production of 700 kg/ha/yr.

Recent Development

In recent years, the Department of Fisheries has developed methods of artificial breeding of carps and rearing of fry and fingerlings and succeeded, to a limited extent, in transferring these technologies to some private fish seed producers. As a result, better quality fish seed of known species are now available to many farmers. Primarily because of this break through in carp breeding technology and the introduction of improved methods of fish pond management, a large number of fish farmers are now achieving production of 1000 - 1500 kg/ha/yr. However, the production technology presently being followed by the farmers do not allow them to take full advantage of the production potential of their ponds. Nowadays, better and more appropriate technologies for fish culture are available in Bangladesh. Successful transfer of these technologies to rural fish farmers would ensure many fold increase in fish production from rural ponds. This has been demonstrated on a pilot scale by the FAO/UNDP Project "Institutional Strengthening in the Fisheries Sector" (BGD/87/045) through its extension activities in 42 thanas (lowest administrative unit) under 12 districts, where 533 Result Demonstration Fish Farmers (RDFFs) and 3806 Fellow Fish Farmers (FFFs) have been assisted. These farmers are practising semi-intensive fish culture using their own resources and without any material input or credit support either from the Government or from the project. The RDFFs have achieved an average production of 3.5 t/ha/yr. It has been demonstrated that the technology is appropriate in that it is technically feasible, economically viable and socially acceptable. Moreover, all the inputs used are locally available.

The Technology

Because the technology transferred to the farmers is appropriate, it is expected to have a high degree of sustainability. The basic technology involves careful pond preparation, which includes eradication of unwanted fish species, eradication of weeds, basic manuring using locally available manure and household farm wastes, etc. Pond preparation is followed by stocking of 4000-6000/ha healthy carp (major Indian and Chinese) fingerlings of 10-15 cm size and in various combinations of species depending on the pond condition. After stocking, the daily manuring schedule using mainly animal wastes and some inorganic fertilizer is practised. Since the cost of supplementary feed amounts to nearly 70% of the total cost of fish culture, only the farmers who can afford it are advised to follow supplementary feeding schedule. Most of the farmers take the advantage of rich natural feed that is generated by regular manuring of the pond water. The pond bottom is regularly raked to help release nutrients and poisonous gases. Unlike traditional methods of pond preparation in the summer months, the farmers are advised to prepare pond in the winter months and stock their ponds with bigger fingerlings reared through the autumn, thus taking advantage of the fast growing period of the summer months.

Technology Transfer

The adapted culture technology has been transferred to the fish farmers through the extension services component of the project. The baseline socio-economic information showed that the clientele were mostly illiterate or semiliterate; following the traditional extensive culture practices; without any capital of their own for investment; and unable to obtain institutional credit. However, the farmers were found to be eager to accept improved technologies and were willing to train neighbouring farmers through result/method demonstration in their own ponds.

The project therefore selected Result and Method Demonstrations as the vehicle for the transfer of technology to the farmers. And for the rapid transfer of the technology to the maximum number of farmers within the project life, the project followed the Trickle Down System (TDS) of extension approach.

The TDS for fish culture extension services, introduced by this project, is based upon training of Fellow Fish Farmers (FFFs) through demonstration in the ponds of the Result Demonstration Fish Farmers (RDFFs). Under this system, to start with, selected fish farmers were trained in semi-intensive polyculture of fish in their own ponds under the close guidance and supervision of the Extension Officers. On completing their training and after successfully completing one production cycle, these fish farmers graduated to become RDFFs. In the following production cycle each RDFF provided hands-on training to 5-10 neighbouring FFFs as his contribution to socio-economic development of his community. A Fellow Fish Farmer graduated to a RDFF on completion of his training for one grow-out period; and then took another 5-10 new FFFs under his care and trained them until they graduated to RDFFs. Thus the know how of improved fish culture technology trickled down from the Extension Officer to RDFFs and ultimately to the FFFs and as a result the number of fish farmers brought under the system increased in geometric progression (Fig. 1). Following the TDS approach the project succeeded in bringing 533 RDFFs and 3806 FFFs under its extension services. The farmers did not receive any financial or material support from the government. In recognition of their services to the community, the project, however, awarded certificates and medals to the RDFFs. Therefore, the key elements of TDS are:
(i) Fishery Extension Officer/Agent; (ii) Result Demonstration Fish Farmers; (iii) Fellow Fish Farmers; (iv) appropriate fish culture technologies; (v) provision for adequate and appropriate training for Extension Agents; (vi) Result/Method Demonstration; and (vii) effective monitoring through good record keeping and reporting.

The advantages of the Trickle Down System of fish culture extension approach as experienced by the project in Bangladesh are summarized below:

- created an environment of continued learning for extension agents and farmers
- helped to develop self-confidence and self-reliance in extension agents and farmers
- created a large pool of extension volunteers within a short-time
- allowed fish farmers from different socio-economic strata to participate in the development process
- ensured sustainability of the technology transferred
- allowed tailoring the technology according to the needs and capacity of the farmer
- because of cooperative efforts, the farmers found it possible to practise fish culture without subsidies and credit support.

Conclusion

On a limited scale the FAO/UNDP Project BGD/87/045 has demonstrated that without credit support and government subsidies and with the existing staff strength it is possible to increase pond fish production form the present average production of 1000 t/ha/yr to 3.5t/ha/yr. In addition to increasing fish production, pond fish culture seems to be the right vehicle for socio-economic upliftment of the rural population. Many homesteads in rural Bangladesh own a pond for multipurpose use. However, due to poverty, illiteracy and lack of information, the farmers follow the traditional method of fish culture. With little input these underutilized ponds could be made highly productive, creating gainful employment opportunities for the unemployed/underemployed members of the rural communities. In addition, adoption of improved culture technology would have a significant positive impact on the nutritional status of the rural population.

Encouraged by the success of the pilot demonstration, the government of Bangladesh has decided to adopt this improved culture technology nationwide, following the TDS of extension approach.

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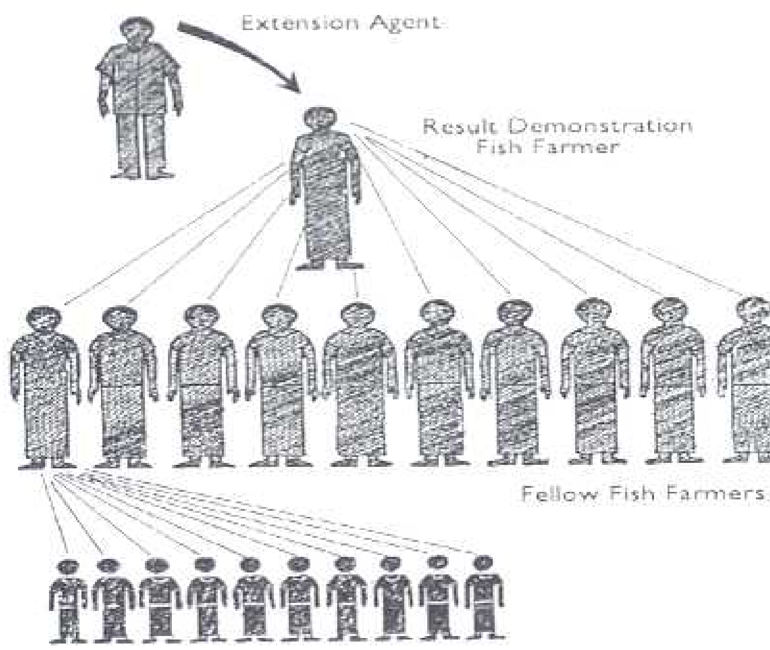
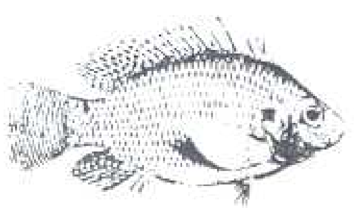


Trickle Down System of Aquaculture Extension

FAO/UNDP assistance for the development of fish farming in the landlocked LAOS PDR started in 1979 with the launching of the project "Rehabilitation of Fish Seed Farms and Fish Culture Development" (LAO/78/014). Through this and its successor project, LAO/82/014, during the period 1979-90, the country's existing fish seed farms were rehabilitated; new fish seed farms were established; integrated fish culture pilot/demonstration farms were built and some government officers and fish farmers were trained.

The ongoing project LAO/89/003 - Development of Fish Culture Extension - a 4 year project, commenced operation in April 1992 with a view to establishing an effective fish culture extension service. The project is designed to establish integrated fish culture demonstration farms at district level, train government (central and provincial level) extension officers and fish farmers, and develop a credit scheme for the fish farmers. The project, in its second year of operation, is proceeding on schedule. The project's TCDC programme deserves special mention, as it has successfully carried out a study tour exchange programme of Laotian and Vietnamese aquaculture officers. The project is also planning similar TCDC activities between Laos and Myanmar.

[Further information can be obtained from Mr. X. Lu, FIRI, FAO, Rome]

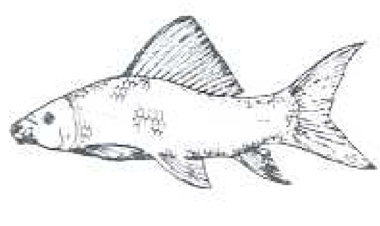


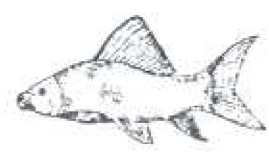
FAO NEWS ITEMS

To improve socio-economic conditions of coastal fishing communities by providing alternative employment/income opportunities through diversified seaweed farming, an UNDP/FAO project, "Seaweed Production Development" (PHI/89/004), is being implemented in the Philippines. The project is designed to develop farming techniques for the major Gracilaria species under local conditions, establish pilot sites to demonstrate such farming techniques, develop village-level seaweed processing techniques, develop marketing of agar, and organize community-based groups to undertake coastal resources management activities.

This 3 year project became operational in August 1991 and is progressing on schedule. Experimental farming trials of Gracilaria at five demonstration sites have been completed, with growth rates comparable to commercial scale farming of Euchauma. Commercial production trials are now in progress. The two main methods of cultivation being used in the trials are fixed bottom monoline and floating raft monoline. Three environmental conditions have also been identified, viz. high salinity/clear water/firm substrate, high salinity/semi-clear water/sandy-mud substrate and low salinity/semi-clear water/muddy substrate. Also, production-oriented studies are in progress to determine technical feasibility and economic viability of alternative farming techniques, such as seaweed polyculture with fish/shrimp in ponds. Cooperative development activities and training on seaweed farming, processing, marketing and resource management are presently being carried out by the project. Technical reports, pamphlets and a manual on Gracilaria farming have also been completed. Also, a socio-economic study in the project area is in progress. Gracilaria processing and agar quality analysis laboratories have been established, and the development of village level processing technology is in progress. The project has also established linkages with the University of the Philippines, NACA and other related projects in the region. The national staff, working together with the project experts, receiving training in all aspects of seaweed culture.

[Further information can be obtained from Mr. X. Lu, FIRI, FAO, Rome]



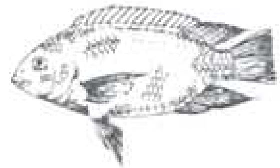


The Ministry of Fisheries of Viet Nam in cooperation with the Global Fish Disease Information Exchange and Diagnosis Services System project (GCP/INT/526/JAP) of FAO will hold in Hanoi from 28 July to 7 August 1993, an international workshop and training course on "Quick Diagnostic Methods and Biological Control of Fish and Shrimp Diseases". The workshop will have country reports from Thailand, Indonesia, China, Philippines, Malaysia, India, Bangladesh and Nepal; lectures on various aspects of diagnostic methods and bio-ecological control; and round-table discussions. The training course will include various diagnostic techniques used for the identification of disease-causing fungi, bacteria and viruses.

[Further information can be obtained from Dr. T. Matsusato, FIRI, FAO, Rome]

The Ministry of Agriculture and Food Economy of the Government of Poland in cooperation with the Global Fish Disease Information Exchange and Diagnosis Services System Project (GCP/INT/526/JAP) of FAO will hold in the Inland Fishery Institute (Olselyn)/National Veterinary Research Institute (Pulawy) from 23 August to 3 September 1993, an international workshop and training course on Fish Disease Diagnosis and Prevention Methods. The workshop and the training course have been designed for fish health management experts and fishery officers/technicians in the public and private sectors. The course will give special emphasis on the role of biodefence system in prevention and therapy of fish diseases; role of immune response in prophylaxis infectious diseases; effects of environmental contamination on the non-specific defence mechanism and specific immune response; application of new immunological techniques for control of defence mechanisms and diagnosis of fish diseases, etc.

[Further information can be obtained from Dr. T. Matsusato, FIRI, FAO, Rome]



Under the TCP project on "Fisheries Research and Planning" an assessment of the status of aquaculture in Argentina has been made. At present commercial aquaculture is limited to several freshwater species. In 1992, aquaculture production was estimated at 801.5 t, of which rainbow trout accounted for 800 t and the remainder was malaysian freshwater shrimp. very small quantities of bull frog and ornamental fish (mainly gold fish) are also cultured.

Although there are good potentials for the development of commercial aquaculture, marketing of aquaculture products has been identified as the most serious constraint to its present and future development. Under the present circumstances, the possibilities for the expansion of the internal market and the opening of new export markets seem to be very slight. Argentina has one of the highest meat consumption rates (100 kg/person/year) in the world, and most people eat very little fish and shellfish products (4.4 kg/person/year). However, in recent years more and more private investors (individuals and companies) have shown interest in aquaculture. The project, in its final report, has recommended for the government to formulate and support a national aquaculture development Programme, in collaboration with the provincial governments, universities and the private sector. Specific recommendations for the identification and development of local and export markets have also been made.

[Further information can be obtained from Manuel Martinez, FIRI, FAO, Rome]

In Mozambique, a "Pilot Project for Coastal Shrimp Culture " (MOZ/86/033) will be completed in the near future. The project is funded by UNDP and is executed by FAO. Approved in 1988, the project constructed a pilot farm in an abandoned saltwork at costa do Sol, a resort area about 6 km from Maputo City. After a rather long initial delay, 8.5 ha of ponds were brought under shrimp culture operation and four experimental production cycles were completed. The location of the farm is suboptimal in terms of temperature, especially during the winter months.

The post-larvae of *P. monodon*, the most important commercial species, are practically non-existent in the project area. Post-larvae of *P. indicus*, the second most important commercial species, accounted for 20 % to 30% of the post-larvae and juveniles collected. The total amount collected from the Maputo Bay area was not sufficient to stock the farm. Other regions of the country, further north, are known to have more abundance of these post-larvae but were not accessible.

Other shrimp species (*P. japonicus, P. semisulcatus, M. monoceros, M. stebbingy*) found in the area were tested for survival and growth. Besides *P. indicus, P. semisulcatus* was the only species which attained 10-12 g in 150 days. This size of head-on shrimps are nowadays acceptable in some European markets. The *P. monodon* post-larvae were imported as they were not available locally. Efforts were also made to produce a formulated shrimp feed using the locally available ingredients.

All the technical, biological and economic data/information are now being analysed with a view to assessing the overall technical feasibility and economic viability of this pilot operation. If found feasible and viable, the government of Mozambique would consider building a shrimp hatchery and expanding the grow-out operation to approximately 70 ha.

[Further information can be obtained from Manuel Martinez, FIRI, FAO, Rome]

The FAO has organized three special studies, one each for Latin America, North Africa and Africa south of Sahara. These studies are evaluating the state of aquaculture development in order to decide on the priorities for short and medium term research programmes of regional or sub-regional interest. Cooperation from other organizations has been obtained for the funding of these studies, namely the Italian Government through the AQUILA II Project for the Latin American Region, the Economic Commission for Africa (ECA) and the Commission of European Communities (CEC) for the study in Africa South of Sahara, and IFREMER (French Government) for the Study in the North African countries. The implementation of the studies in the three regions are being carried out with close cooperation of the FAO regional aquaculture projects viz. AQUILA II, ALCOM and MEDRAP II.

The studies are based on the national reports prepared by selected national authors following a common outline. The main outputs of these studies are the Regional Synthesis and Indicative Action Plans. For Latin America, the draft synthesis and a preliminary action plan have been discussed at the Sixth Session of the Working Party on Aquaculture of Commission for Inland Fisheries of Latin America (COPESCAL), held in Cartagena, Colombia from 12 to 16 July 1993; and the other two draft reports and action plans will be discussed in the appropriate forum in the near future. An article on the COPESCAL and CIFA meetings will be included in the next issue of the FAN.

[Further information can be obtained from Mario Pedini, FIRI, FAO, Rome]

NEW PUBLICATIONS

Tacon, A.G.J. Feed ingredients for warmwater fish: Fish meal and other processed feedstuffs.
FAO Fisheries Circular (856), Rome, FAO. 1993. 64p.

The document reviews the major animal and plant feed ingredients used within compound aquafeeds for warmwater fish, including fish and fishery by-product meals, terrestrial animal by-product meals, grain legumes and by-product meals, cereal grains and by-product meals, and miscellaneous and products. Information is presented concerning the nutritional value and chemical composition of individual feed ingredient sources, together with their normal dietary inclusion levels. In addition, the document presents information on world aquaculture production and highlights the current trends and future prospects of feed ingredient usage within aquafeeds.

Lu Xiangke. Inland Fisheries of Indo-Pacific countries
FAO Fisheries Circular (794) (Rev 1), Rome, FAO, 1993, 46p.

This document contains updated reviews of the status of inland fisheries for the following countries of the Indo-Pacific region: Australia, Bangladesh, Cambodia, China, Malaysia, Myanmar, Nepal, New Zealand, Papua New Guinea, Philippines, Sri Lanka, Thailand and Viet Nam. The information provided for each country includes; area, population, total catch, physical geography, climate, hydrology with information on rivers, lakes and reservoirs, land and water use, inland fishery yield/production for the last 10 year period, state of the fishery with information on the yield, factors influencing the yield, and inland fishery development forecast. The document is to be updated and expanded, as more information becomes available.

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