ISSN 1020-3443

FAN

The FAO Aquaculture Newsletter

April 1998, No. 18

Inland Water Resources and Aquaculture Service, Fisheries Department, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, 00100 Italy
Tel: 39-6-57054795 Fax: 39-6-57053020. E-mail: Ziad.Shehadeh@fao.org

Experimental rice-fish farming in the Philippines (courtesy of M. Halwart and kind permission of Margraf Verlag, Weikersheim, F.R. Germany)

CONTENTS

The FAO Aquaculture Newsletter (FAN) is issued three times a year by the Inland Water Resources and Aquaculture Service, Fishery Resources Division, of FAO's Fisheries Department, Rome, Italy. It presents articles and views from the FAO aquaculture programme and discusses various aspects of aquaculture as seen from the perspective of both Headquarters and the field programme. Articles are contributed by FAO staff from within and outside the Fisheries Department, from FAO regional offices and field projects, by FAO consultants and, occasionally, by invitation from other sources. The FAN is distributed free of charge to various institutions, scientists, planners and managers in Member Countries and has a current circulation of about 3,000 copies. It is also available on the FAO internet Home Page: http://www.fao.org/waicent/faoinfo/fishery/newslet/newslet.htm

Editor: ***Ziad H. Shehadeh***
Editorial Board: ***Jiansan Jia, Mario Pedini, Albert Tacon, Izzat Feidi***
Layout and Production: ***Sylviane Borghesi.***

EDITORIAL

Implementation of the Code of conduct for responsible fisheries: A shared responsibility

The 1982 United Nations Convention on the Law of the Sea provided the required legal framework for improved fisheries management and UNCED Agenda 21 completed this framework in the area of environmental conservation. FAO fostered their practical implementation through a transparent and participatory process, involving Member Nations and other stakeholders of the fisheries and aquaculture sectors, through the FAO Committee on Fisheries (COFI). The Organization collected the dispersed and closely related provisions related to fisheries and aquaculture into a single and focused practical tool - the Code of Conduct for Responsible Fisheries, which was adopted by the FAO Council in 1995.

The Code will promote and facilitate sound aquaculture and fisheries management and development and enhance fisheries governance. It will also provide the Fisheries Department with a unique integrated frame, together with the outcome of the World Food Summit, for its programme. At the regional level, fishery bodies have an important role to play in facilitating the implementation of the Code, and for this reason, the draft FAO Strategy to support implementation that will be presented for consideration at the Twenty-third Session of COFI in 1999, underscores the importance of regional action. With respect to national implementation of the Code, governments have been encouraged to work with other stakeholders to facilitate structural adjustments and change in the fisheries sector.

At the Twenty-second Session of COFI in 1997, the Code was addressed as a substantive item. The Committee underlined the need to secure funding to support the implementation of the Code in developing countries, and for monitoring and reporting on its implementation. It also agreed that progress reports should be presented by FAO to the Committee at every session. The reports would address achievements, progress and constraints in implementation. Governments and other stakeholders and interest groups would be requested to provide information to FAO on progress with national implementation through the use of a questionnaire to be developed by the Secretariat. This information would then be incorporated into a consolidated report to the Committee.

The Secretariat has developed and field tested a questionnaire for this purpose. It consists of seven sections, each addressing a specific substantive article of the Code. It aims at obtaining simultaneously, quantitative and qualitative information on key indicators of progress in the implementation of the Code. Information will be solicited both electronically, through E-mail and special web site, and by ordinary mail. Administration of the questionnaire will be undertaken from May through July 1998. FAO has established a site for the Code on the FAO Home Page on the web (http:\\www.fao.org\fi), which is updated regularly, providing information on developments with the Code.

Monitoring and reporting on the implementation of the Code is a shared responsibility. The co-operation of governments in providing information for the Code web site and in responding to the questionnaire will be highly appreciated.

Benedict P. Satia
Chief, International Institutions and Liaison Service (FIPL)
Policy and Planning Division,
and
Secretary, Committee on Fisheries

Trends in Rice-Fish Farming

Matthias Halwart
Fishery Resources Division

BACKGROUND

Rice is grown in irrigated, rainfed lowland, flood-prone, and upland ecosystems. The irrigated rice ecosystem, with approximately 81 million ha worldwide, accounts only for 53% of the world's harvested area of rice but produces 76% of the global rice production. Of the remaining area 27% is rainfed lowland, 8% is flood-prone, and 12% is upland. In the 1990s the world rice area has remained more or less constant at about 148 million ha. Almost 90% of this area is in Asia. India is the largest grower of rice with 42.3 million ha followed by China with 33.0 million ha (Table 1). The irrigated rice environment is supposed to be the main contributor to the much needed future increase in production, but yields under continuous and intensive cropping conditions are either stagnating or declining.

As a result of development aid donors and governments focus on sustainable rural development, food security, and poverty alleviation, rice-fish farming systems have received a great deal of attention in the recent past. Several reviews on historical, socio-economic, and ecological aspects of rice-fish farming have been published in the past decade with either a global or a national focus (Li, 1988; Fernando, 1993a; Halwart, 1994a; MacKay, 1995; Choudhury, 1995; Little *et al*., 1996). Country overviews have been provided for Bangladesh, China, India, Indonesia, Korea, Malaysia, Philippines, Thailand, Viet Nam, and Madagascar (for Asian countries: dela Cruz *et al*., 1992; for Madagascar: Symoens and Micha, 1995). An extensive bibliography on diverse aspects of fish culture in rice fields has recently been compiled by Fernando (1993b).

Rice-fish farming systems can be broadly classified as capture or culture systems depending on the origin of the fish stock. In the capture system wild fish enter the rice fields from adjacent water bodies and reproduce in the flooded fields. In contrast, rice fields are deliberately stocked with fish in the culture system either simultaneously or alternately with the rice crop. The rice fields may be used for the production of fingerlings or table fish depending on the size of fish seed available for stocking, the duration of the fish culture period, and the market needs for fingerlings or table fish.

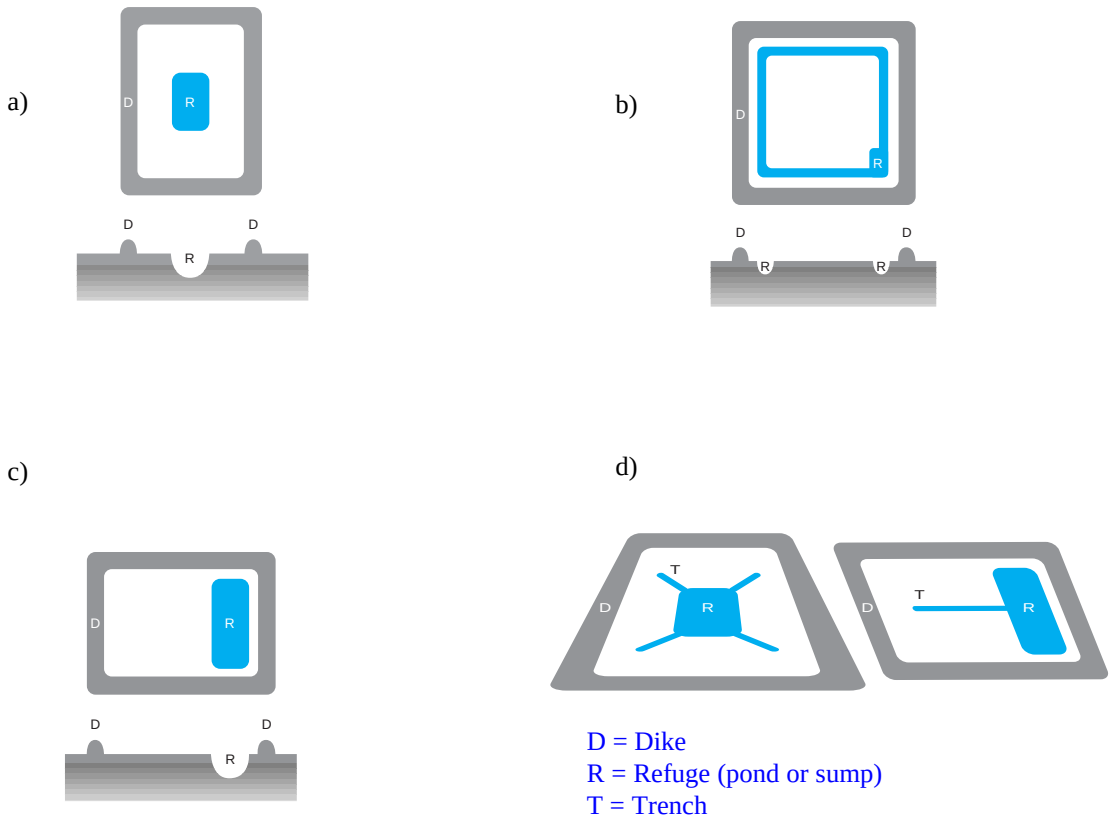
Technical details of the few physical modifications (bunds, trenches, water inlets and outlets) that are required to make the rice field suitable for fish farming have been described elsewhere (e.g. Capistrano-Doren and Luna, 1992). It is however interesting to note the differences in refuge size and shape. It can be a pond within or adjacent to the rice field, or a trench which may be central or lateral, or a combination (Figure 1 a - d). Different extremes for the size of this refuge area can be observed. For religious reasons farmers just dig a small sump in the rice field terraces in the Ifugao province in the Philippines, whereas in Viet Nam sometimes up to half the ricefield area is dug out because profits from fish sales exceed those from the rice crop.

Table 1. Distribution of rice and rice-fish crop area, by environment.

Country	Rice					Rice-fish
	Total	Irrigated	Rainfed lowland	Floodprone	Upland	
	(000 ha)	(%)				(000 ha)
Bangladesh	10245	22	47	23	8	?
Cambodia	1910	8	48	42	2	?
P.R. China	33019	93	5	-	2	1204.9
Egypt	462	100	-	-	-	172.8
India	42308	45	33	7	15	?
Indonesia	10282	72	7	10	11	138.3
Korea, Rep.	1208	91	8	-	1	0.1
Lao PDR	557	2	61	-	37	?
Madagascar	1140	10	74	2	14	13.4 (highlands)
Malaysia	691	66	21	1	12	?
Philippines	3425	61	35	2	2	?
Sri Lanka	791	37	53	3	7	?
Thailand	9271	7	86	7	1	25.5 (culture) 2966.7 (capture)
Viet Nam	6303	53	28	11	8	40.0 (Mekong Delta)

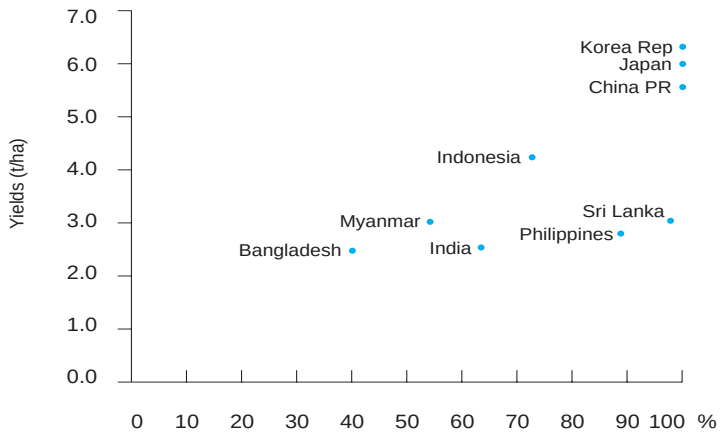
Note: Distribution of rice crop area, by environment, 1991 (after FAO AGROSTAT, 1994 and IRRI RICESTAT, 1994 in IRRI, 1995). Irrigated - rice is transplanted or direct seeded in puddled soil on leveled, bunded fields with water control, in both dry and wet seasons in the lowlands, in the summer in higher elevations, and during the dry season in flood-prone areas. Rainfed lowland - rice is transplanted or direct seeded in puddled soil on level to slightly sloping, bunded or diked fields with variable depth (up to 50 cm) and duration of flooding, depending on rainfall. Flood-prone - rice is direct seeded or transplanted in the rainy season on fields characterized by medium to very deep flooding (50 cm to more than 300 cm) from rivers and from tides in river mouth deltas. Upland - rice is direct seeded in nonflooded, well-drained soil on level to steeply sloping fields in plateau and hilly areas. For sources on extent of rice-fish area, please refer to the text.

Figure 1a - d. Examples of various refuge layouts in rice-fish farming



Rice varieties are selected by the farmer for their suitability to agroclimatic conditions and preferred consumer taste. Past increases in rice yields have mainly come from the gradual reallocation of land from traditional to the high-yielding modern varieties. These are short, stiff-strawed, fertilizer-responsive, photoperiod-insensitive, and have short to medium growth duration (100-130 days). The use of long-stemmed long-maturing traditional varieties allows a higher water table and an extended period for fish farming. However, as the case of the P.R. China (with 1.2 million ha under rice-fish farming in a rice area almost exclusively planted to modern varieties) shows, the use of modern rice varieties is not a constraint for rice-fish farming (Figure 2).

Figure 2. Percent rice area under modern varieties and rice yield, 1985-93. (after IRRI, 1995)



Rice area under modern varieties (%)

Many fish species can be harvested from rice fields but only few are commercially important. The most common and widespread fish species used in rice-fish farming are the omnivorous common carp *Cyprinus carpio* and the planktivorous Nile tilapia *Oreochromis niloticus*. They feed low in the food chain and are therefore preferred species in the culture systems. Other popular species are *Puntius gonionotus* and *Trichogaster* spp. Many air-breathing species such as the snakehead *Channa striata* or catfishes *Clarias* spp. are well adapted to the swamp-like conditions of rice fields, with fluctuating water levels, and are highly appreciated wild fish in the capture system. They are carnivorous and will feed on other introduced fish but, for example in Thailand, can be sold for twice the price of cultured fish at local markets.

Generally, Integrated Pest Management (IPM) practices are recommended for rice-fish farming. The use of pest and disease resistant rice varieties is encouraged to minimize pesticide application. In rice monoculture, the chance of pests reaching a population level which economically justifies control action is usually low. The potential income from fish shifts the economic threshold to a level which is even less likely to be reached by pests. Also, from an IPM point of view, fish culture and rice farming are complementary activities because it has been shown that fish further reduce pest populations. Evidence from the FAO IPM Intercountry Programme in Indonesia shows that, through IPM, the number of pesticide applications in rice can be reduced from 4.5 to 0.5. This not only reduces costs but also eliminates an important constraint to the adoption of fish farming. Therefore training in IPM for many farmers participating in the regional programme in Bangladesh, Indonesia, or Viet Nam has been an entry point to rice-fish farming.

Simultaneous culture of fish with rice often increases rice yields, particularly on poorer soils and in unfertilized crops, probably because under these conditions the fertilization effect of fish is greatest. With savings on pesticides and earnings from fish sales, increases in net income on rice-fish farms are reportedly 7 to 65% higher than on rice monoculture farms.

CURRENT STATUS AND TRENDS

Rice-fish farming is a traditional practice in hilly areas in the south of the P.R. China, particularly in provinces close to the Yangtse River and Pearl River, because either common carp eggs were collected

there and put into rice fields for hatching, or broodstock was released into rice fields for natural spawning. Significant progress was made in the 1980s when many other fish species (grass carp, crucian carp, silver carp, bighead carp, etc.) in combination with new production techniques (e.g. 'rice on ridge - fish in furrow' cultivation, raising fish with azolla) were tested. Sichuan with 333,300 ha of rice-fish farming, Hunan (227,000 ha), and Guizhou (87,300 ha) were the three top provinces in terms of area (Figure 3). An average annual fish production from concurrent rice-fish farming of 180 kg/ha has been reported although fish yields exceeding 750 kg/ha can be achieved (production patterns and technologies, ecological interactions, and economic benefits are described and analyzed in MacKay, 1995). Production is approximately twice as high in rotational rice-fish farming systems. P.R. China officially promotes fish farming in rice fields in its National Aquaculture Development Plan (FAO and NACA, 1997), but the rise in freshwater fish prices is probably an important incentive for a more rapid adoption of this integrated farming (the average price for common carp in P.R. China increased by 47% from 1992 to 1995, (FAO, 1997)). According to the most recent figures provided by the Bureau of Fisheries, Ministry of Agriculture, P.R. China, there has been a continuous increase in fish production from rice fields with a peak of 377,000 t on an area of 1.2 million ha reported in 1996 (Figure 4).

The second most important country in terms of rice-fish area is Egypt. There has been a considerable expansion in rice-fish area in the 1980s with a peak of 224,917 ha in 1989, at a time when the price of rice was not favourable (in comparison to other summer crops) and new reclaimed salt-affected land was taken under cultivation with continuous flooding and fish production. This situation changed after 1989. Rice prices increased, the adoption of high yielding rice varieties led to a higher productivity, and reclaimed lands were converted to rice monoculture. As a consequence, the rice-fish area has declined to 172,800 ha in 1995, which is still equivalent to 37% of the rice area (Figure 5). Fish production from rice fields accounted for 32% of the total aquaculture production of the country in 1995 (Shehadeh and Feidi, 1996).

In Indonesia the fast development of grow-out operations, such as running water systems and cage culture in reservoirs, has fueled an increased demand for fingerlings. With limited nursery capacities, the potential of using rice fields quickly became evident and rice-fish farming for fingerling production became popular among rice farmers. In the period 1977 to 1984 fish production from rice fields increased from 17,701 to 58,880 t. The area under rice-fish peaked in 1982 with 137,384 ha under production. Although the rice-fish area decreased to 94,309 ha in 1985, total fish production from rice fields increased with average annual fish yields reaching 670 kg/ha, more than double the production of 306 kg/ha in 1982. Rice-fish farming is practised in 17 of the 27 provinces in Indonesia, in particular in all provinces in Java and the northern provinces of Sumatra except Riau and Jambi. Most of the 94,309 ha recorded in 1985 are located on Java (64,855 ha), followed by Sumatra (14,387 ha), Bali-Nusa Tenggara Islands (9,361 ha) and Sulawesi (5,706 ha). No records or few data exist for Kalimantan, Maluku, Irian Jaya or the outer islands but rice-fish farming is probably more widespread than indicated by current data (Koesoemadinata & Costa-Pierce, 1992). After 1986, rice production practices in Indonesia changed dramatically when IPM was declared the official national pest control strategy. Pesticide subsidies were removed, and 57 out of 66 insecticide formulations used on rice were banned. How IPM served as an entry point for rice fish farming is perfectly documented in the case of an Indonesian farmer (Van de Fliert and Wijanto, 1996). The latest figure (1995) on rice-fish area (138,277 ha), provided by the Indonesian Directorate General of Fisheries (Siregar *et al.*, 1998) indicates that rice-fish farming is on the rise again.

It is difficult to get reliable figures on rice-fish farming in Thailand because the volume of the traditional capture of fish in 'trap ponds' is generally not recorded. However, with 86% of its rice area being rainfed, *ricefield capture fisheries* plays a dominant role. In approximately one third of the country's 9.3 million ha rice lands, fish are captured at average yields of 25 kg/ha. In addition to this, there is a significant catch from small ponds constructed for water holding purposes along streams and canals and ditches between roads and rice fields. *Ricefield culture fisheries* was reported from 2,820 ha in 1983 (mainly Central, North, and Northeast Provinces). The steep production increase in the 1980s can probably be attributed to two major factors: a general decrease in wild fish availability, further aggravated by the occurrence of the ulcerative disease syndrome in wild fish stocks from 1982 onwards, and an improved supply and distribution of cultured fish seed. The combined impact of these factors was so significant that the area of ricefield culture fisheries expanded to 23,900 ha in 1988 and further increased to 25,500 ha in 1992 (FAO and NACA, 1997).

Figure 3. Area sown to rice in P.R. China, 1989-90, by province, exclusive of Taiwan Province of China (modified after Huke *et al*., 1993). Sichuan, Hunan, and Guizhou are the most important rice-fish provinces (see text for details).

China - Rice Area 1989 - 90 (000 ha)

	no data
	0 to 500
	500 to 1000
	1000 to 2000
	2000 to 3000
	3000 to 4000
	4000 to 5000

Figure 4. Rice-fish area and fish-production in rice fields of the P.R. China

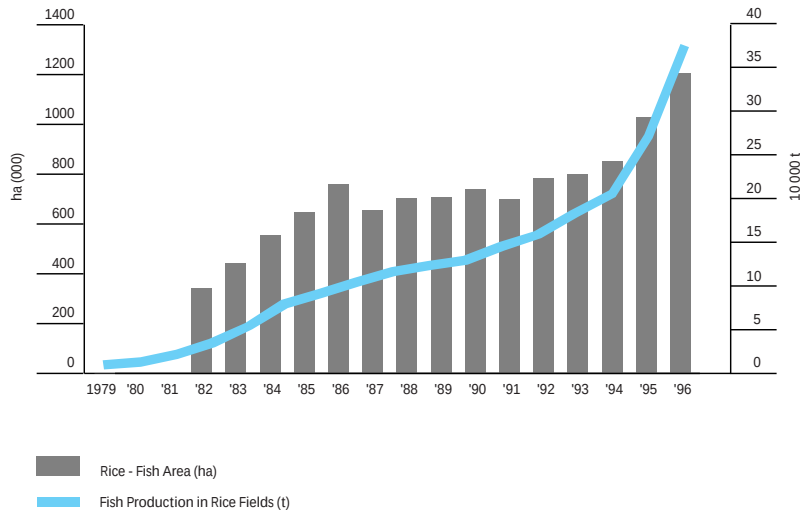
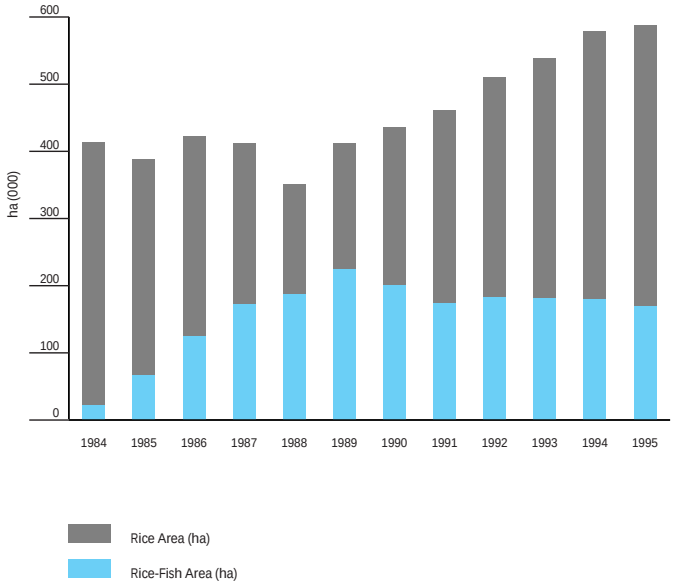


Figure 5. Rice and rice-fish area in Egypt



In most other countries, fish farming in rice fields is not recorded in the national statistics, but many have initiated research and extension activities. Where rice-fish farming is a new practice, technical, social and economic feasibility should first be investigated. UNDP-supportedon-station and on-farm research on the integration of rice and fish farming is currently underway in Sri Lanka. A promising system is the nursing of fry to fingerlings in rice fields since there is a large demand for fingerlings to be stocked in the abundant seasonal and perennial freshwater reservoirs of the country.

In India, rice-fish farming is considered particularly suitable for the less productive rainfed areas. The Indian Council of Agricultural Research, in its 1996 Newsletter, reported a twelve fold increase in economic benefit from an integrated rice-fish system with vegetable or fruit crops grown on the bunds, as compared to traditional rice farming. The economics and risks of rice-fish farming have also been the subject of study in the Philippines to determine why rice-fish farming has not been widely adopted by farmers in the country. A different approach was taken in Madagascar. The FAO/UNDP supported projects initially focused on optimizing different rice-fish farming techniques, but later shifted to tackling the two major constraints which had been identified: Ignorance of appropriate fish breeding techniques and lack of fry (Randriamiarana *et al.*, 1995). Private sector involvement proved to be the key for overcoming these limitations (see also Van den Berg, 1996). By 1992, 1,085 tons of fish were produced in 13,400 ha rice fields. However, the project has ended and it is not known whether rice-fish farming has been sustained or the intended multiplier effect through the private sector has actually taken place. In Malawi, a GTZ-funded project of the International Center for Living Aquatic Resources Management (ICLARM) now examines farmer-driven rice-fish extension, and in Ghana the inclusion of fish farming in irrigation schemes has been tried. ICLARM plans to continue similar projects with Zambia, Zimbabwe, Malawi, and Egypt (Prein, pers. comm.). The FAO-implemented regional (Africa) project, ALCOM (Aquaculture for Local Community Development Programme), has actively promoted rice-fish farming with an emphasis on social and

economic aspects in the SADC region since 1986. Under FAO's new Special Programme for Food Security (SPFS), fish farming in irrigation schemes in LIFDC countries currently receives a great deal of attention.

Invaluable research and coordination work has been performed by the two CGIAR (Consultative Group on International Agricultural Research) centres with a mandate for rice and fish farming, the International Rice Research Institute (IRRI) and the ICLARM. Supported by ADB and IDRC in the late 1980s/early 1990s and operated through the Asian Rice Farming Systems Network (ARFSN), the two centers have collaborated with many national institutions to improve existing rice-fish farming systems and to facilitate information exchange among participating countries. The technical feasibility and the improvement of rice-fish farming systems is still an important issue today in many locations but is usually considered in a more holistic way within the framework of socio-cultural and economic constraints. For example, an USAID funded project between ICLARM, the Bangladesh Fisheries Research Institute (BFRI) and various NGOs has studied concurrent rice-fish farming in medium highlands and lowlands and rotational culture in deeply flooded lowlands in order to develop sustainable low-external input practices that fit into the existing farming systems. In an on-going IFAD funded project, ICLARM also collaborates with the Bangladesh Rice Research Institute (BRRI) and BFRI to develop options for rice-fish culture in the flood-prone rice ecosystem; e.g. fish farming in net enclosures, and to carry out studies on community management.

In Lao PDR the FAO Project "Development of Fish Culture Extension" has promoted improved practices of rice-fish farming including the development of technical capacity at national and provincial levels (see also *FAN*, vol. 14, p. 29). FAO and UNDP continue to support rice fish systems in a follow-up project (LAO/97/007) in 5 provinces. Also in Lao PDR, where mostly the traditional ricefield capture fisheries can be found with various forms and degrees of community management, a DFID[1]-funded on-farm research project on rice-fish farming is underway addressing technical, social, and economic constraints to rice-fish culture (Haylor, 1995). The role of women is emphasized. The project links researchers from the Institute of Aquaculture in Stirling, the Agricultural Extension and Rural Development Department of the University of Reading, and the Savannakhet Provincial Livestock and Fisheries Section, with the AIT Aqua Outreach Programme serving as facilitator. Much research has focused on improvements of the traditional rotational rice-shrimp system in seasonal brackishwaters in the Mekong delta in Viet Nam. A Belgian Government funded project between the University of Can Tho and the Catholic University of Leuven aims to improve existing rice-fish farming systems in the Mekong delta. The University of Can Tho also collaborates with ICLARM in an IDRC-funded study on the socio-economics and productivity of integrated farms using the software RESTORE. Also in Europe and the US, the interest in the integration of fish and crayfish with rice farming is revived with researchers and farmers alike. The concurrent cultivation of rice and crayfish *Procambarus clarkii* has been investigated by research institutions in Louisiana, and commercially about 50,000 t are produced in 40-50,000 ha of shallow ponds, many planted with rice. The same species is also produced on a limited scale in rice fields in Spain with annual yields of around 5,000 t. There is apparently interest in culturing tilapia in Spanish rice fields but this has not started (Fernando, pers. comm.). In the Po delta in Italy, rice-fish farming was discontinued during the Second World War. Today, the University of Bologna with support from the Regione Emilia-Romagna has started to investigate fish management in rice fields under modern cultivation, as well as ecological and economic aspects of the integration (Lucchini, 1996).

In Latin America and the Caribbean, rice-fish farming has been tried with an emphasis on the technical feasibility in Argentina, Brazil, Panama, Peru and Haiti (Guillen, 1990). Often, local species have been used such as the silverside (*Odontesthes bonariensis*) in Argentina, or curimatá (*Prochilodus argentes, P. cearanesis*) in Brazil. Satisfactory results have been reported, but further extension is said to be constrained by a lack of trained technical staff, government interest, and international cooperation and promotion.

INTEGRATED PEST MANAGEMENT (IPM)

It is increasingly recognized that Integrated Pest Management and fish farming in rice fields are

[1/] DFID. Department for International Development, formerly ODA.

complementary activities. Several studies on this subject have been supported in the early 1990s by GTZ special projects through the CGIAR centres in collaboration with the Freshwater Aquaculture Center (FAC) in the Philippines, ranging from the biological control effect of fish on rice pests and their natural enemies to the socio-economic dimensions of rice-fish farming and IPM (Halwart, 1994b; Horstkotte, in press). In Bangladesh, two CARE projects (NOPEST and INTERFISH) focus on rice-fish farming as it relates to IPM. They are DFID and EU (European Union) funded and mainly oriented towards training and extension with some limited research. Training subjects in the NOPEST 'training of trainers' programme include, among others, aquatic ecology, fish species selection, water management, fish feeding, fish physiology, fish seed production, and fish transportation. The training of trainers is done in collaboration with government IPM programmes funded by UNDP, and the FAO Intercountry Programme on IPM in Rice in South and Southeast Asia. Also in Viet Nam, many farmers have started fish farming in their rice fields after training in the national IPM Programme. A FAO Technical Cooperation Project, on the management of aquatic pest snails, promotes the use of carps for the biological control of snails, both in rice fields and communal waters (see also *FAN*, vol. 14, p. 30).

Studies relating to the feeding ecology of fish in rice fields receive increasing attention and have been completed in the Philippines, Thailand, Malaysia, and most recently in Bangladesh. Korean researchers have focused on the impact of indigenous fish species on malaria vectors in rice fields. A DANIDA and GTZ supported research area that has received much attention by ICLARM researchers is the modeling of biomass and nutrient flows and the development of sustainability indicators for rice-based fish farming.

Needs and Prospects for Rice-Fish Research and Development

Rice-fish farming will be more adopted the more it is compatible with rice management. The integration seems to have good prospects for the future because the reduction in pesticide applications and the use of less toxic compounds in rice production results in an increased ricefield biodiversity which is not only important for the balance of pests and their natural enemies but also in a nutritional context for farming communities relying heavily on crabs, frogs, or snails from their rice fields. However, implications of the trend of increased use of herbicides in many countries will require further attention in the future.

Since rice can be grown both under submerged or saturated conditions, water is a critical factor in rice production. Much research and development efforts in rice-fish farming have concentrated on irrigated systems because the water level can be easily manipulated, but when farmers have to pump water, the costs often become prohibitive. However, in rainfed lowland rice, farmers tend to hold as much water in the fields as possible (by increasing the height of the ricefield bunds) to 'insure' against insufficient rainfall. One country with predominantly rainfed rice (86%), Thailand, experienced a rapid expansion of rice-fish farming as fish seed availability improved. Similar developments may be expected for rainfed areas in countries as Lao PDR (61%) or Cambodia (48%), where declining wild fish stocks make aquaculture increasingly important.

Most rice-fish research and developments efforts are focused on culture of common carp and Nile tilapia. Promising indigenous species deserve more attention. A new interesting research aspect has been a study on the fecundity of the feral catfish *Clarias macrocephalus* in order to enhance the survival of wild populations in rice fields in Malaysia (Ali, 1993). Fish seed supply and distribution are crucial for the adoption of rice-fish farming. The experience from Madagascar suggests that the private sector may be in a better position to meet this demand, and development agencies increasingly recognize the different roles the public and the private sector may have in national aquaculture development plans. It is imperative that the rate of adoption in Madagascar is evaluated and 'lessons learned' documented especially since external assistance has ended.

Rice-fish farming is particularly expanding in P.R. China where it is not only a traditional practice but is also actively promoted through the National Aquaculture Development Plan. It will be important in the future that Governments actively support the integration of rice and fish farming, and of agriculture and aquaculture, as part of their efforts to enhance food security and ensure sustainable rural development.

ACKNOWLEDGEMENTS

Thanks to the FAN editor, Z. Shehadeh, and FIRI colleagues M. Martinez-Espinosa and D. Bartley for their helpful comments and suggestions. Specific project or country information was provided by A. Ali (University of Science Malaysia), A.T. Badawi (Agricultural Research Center, Egypt), G. Chapman (CARE Bangladesh), C.H. Fernando (University of Waterloo, Canada), K. Gallagher (Global-IPM Facility), N. Innes-Taylor (AIT Aqua Outreach Lao PDR), M. Prein (ICLARM Philippines), A.M. Qureshi/S.P. Chen (FAOR P.R. China), A. Rothuis (University of Can Tho, Viet Nam), D.V. Tran (FAO-AGPC), J. Moehl and H. van der Mheen (ALCOM) and is gratefully acknowledged.

REFERENCES

Ali, A., 1993. Aspects of the fecundity of the feral catfish, *Clarias macrocephalus* (Gunther), population obtained from the rice fields used for rice-fish farming in Malaysia. *Hydrobiologia*, 254: 81-89.

Capistrano-Doren, L. and N. Luna (Eds), 1992. Farmer-proven integrated agriculture-aquaculture: a technology information kit. IIRR and ICLARM, Philippines.

Choudhury, P.C., 1995. Integrated rice-fish culture in Asia with special reference to deepwater rice. *FAN*, 10: 9-16.

dela Cruz, C.R., C. Lightfoot, B.A. Costa-Pierce, V.R. Carangal, and M.P. Bimbao (Eds), 1992. Rice-fish research and development in Asia. International Center for Living Aquatic Resources Management, Manila, Philippines.

FAO, 1997. China's carp market survey report. Unpublished manuscript.

FAO and NACA, 1997. Survey and analysis of aquaculture development research priorities and capacities in Asia, *FAO Fish. Circ. 930.*

Fernando, C.H., 1993a. Rice field ecology and fish culture - an overview. *Hydrobiologia*, 259: 91-113.

Fernando, C.H., 1993b. A bibliography of references to rice field aquatic fauna, their ecology and rice-fish culture. Geneseo, New York, USA.

Guillen, F.Q., 1990. Current status of integrated rice-fish culture in Latin America and the Caribbean. *Int. Rice Comm. Newsl.*, 39: 198-207.

Halwart, M., 1994a. The ecology of fish in rice fields. *Annals of Tropical Research*, X: 1-16.

Halwart, M., 1994b. Fish as biocontrol agents in rice. Margraf Verlag, Weikersheim, Germany.

Haylor, G., 1995. Organic rice with fish on the side: a healthy recipe for Asia? *Aquaculture News*: 46-47.

Huke, R., E. Huke, T. Woodhead, and J. Huang, 1993. Rice - wheat atlas of China. IRRI, CIMMYT, CNRRI.

Horstkotte, G., in press. Economics of rice-aquaculture systems and integrated pest management - a case study from the Philippines. PhD dissertation.

IRRI, 1995. World Rice Statistics 1993-94. International Rice Research Institute, Manila, Philippines.

Koesoemadinata, S. and B.A. Costa-Pierce, 1992. Development of rice-fish farming in Indonesia: Past, present, and future. *In*: dela Cruz, C.R., C. Lightfoot, B.A. Costa-Pierce, V.R. Carangal, and M.P. Bimbao (Eds), 1992. Rice-fish research and development in Asia. International Center for Living Aquatic Resources Management, Manila, Philippines.

Li, K., 1988. Rice-fish culture in China: A review. *Aquaculture*, 71: 173-186.

Little, D.C., P. Surintaraseree, and N. Innes-Taylor, 1996. Fish culture in rainfed rice fields of northeast Thailand. *Aquaculture*, 140: 295-321.

Lucchini, M., 1996. Riso e pesce, un binomio da rilanciare. *Laguna*, 4/96: 34-37.

MacKay, K.T. (Ed.), 1995. Rice-fish culture in China. International Development Research Centre, Ottawa, Canada.

Randriamiarana, H., A. Rabelahatra and J. Janssen, 1995. Rice/fish farming in Madagascar: The present situation, and future prospects and constraints. *In*: Symoens, J.J. and J.C. Micha, (Eds), 1995. The management of integrated freshwater agro-piscicultural ecosystems in tropical areas. Royal Academy of Overseas Sciences, Brussels.

Shehadeh, Z. and I. Feidi, 1996. Aquaculture development and resource limitations in Egypt. *FAN*, 14: 3-7.

Siregar, S.P., P. Erigenius, and M.S. Hastuti, 1998. Paper prepared for the first meeting of the FAO/AIFIC, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

Symoens, J.J. and J.C. Micha (Eds), 1995. The management of integrated freshwater agro-piscicultural ecosystems in tropical areas. Royal Academy of Overseas Sciences, Brussels.

Van de Fliert, E. and Wijanto, 1996. A road to sustainability. *ILEIA Newsletter*, 12: 6-8.

Van den Berg, F., 1996. The private sector: A potential key element in the development of small-scale aquaculture in Africa - lessons from Madagascar. *FAN*, 12: 14-16.

This article is based on the Report of the FAO Technical Consultation on Policies for Sustainable Shrimp Culture, Bangkok, Thailand, 8-11 December 1997. It has been prepared by the FAO Technical Secretariat of the Consultation.

BANGKOK FAO CONSULTATION RECOMMENDS POLICIES FOR SUSTAINABLE SHRIMP CULTURE

Background

There are few economic activities which globally have manifested such high growth rates as the culture of shrimp in coastal areas of developing countries during the last decade. This rapid development has been accompanied by increasingly controversial debates over adverse environmental and socio-economic impacts of shrimp culture.

The underlying cause for such impacts is the absence of effective planning, regulatory and economic incentive policies which address the problem of market failure in the allocation of scarce resources. Market failure is pervasive in the case of many coastal resources such as mangroves, fresh water aquifers and nearshore and estuary environment because of their joint exploitation by many users without proper recognition of their limited sustainable yields and assimilative capacities and inadequate or absent costing of their environmental, economic, social and cultural values. As a consequence, individual shrimp farmers get wrong signals about their true costs of production and hence make sub-optimal decisions on production technology and intensity, siting of ponds, and waste treatment measures.

As part of its priority programme in support of the implementation of the Code of Conduct for Responsible Fisheries, the FAO Fisheries Department convened the Technical Consultation on Policies for Sustainable Shrimp Culture which was held in the FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, from 8 to 11 December 1997. The core task of the Consultation was to develop guidelines on appropriate legal, institutional, regulatory and economic policies for sustainable shrimp culture.

PARTICIPANTS

The Consultation was attended by government delegations and industry observers from twelve countries: Bangladesh, China, Ecuador, India, Indonesia, Malaysia, Mexico, Philippines, Sri Lanka, Thailand, United States of America, and Viet Nam. These countries account for about 90 % of global production of cultured shrimp. The USA, while producing only small quantities of cultured shrimp, is the major shrimp consuming country.

The participants of the Consultation also included observers from the following inter-governmental organizations, all of which have important activities related to various aspects of shrimp culture including research, training and extension, project preparation and funding, market information and others: Association of South East Asian Nations (ASEAN); World Bank; Intergovernmental Organization for Marketing Information and Technical Advisory Services (INFOFISH); Network of Aquaculture Centres in Asia & Pacific Region (NACA); and South East Asian Fisheries Development Center (SEAFDEC).

International non-governmental organizations representing the shrimp culture industry and environmental and small-scale fisheries interests were also present in an observer capacity: Global Aquaculture Alliance (GAA); Greenpeace International; International Collective in Support of Fishworkers (ICSF); and World Wide Fund for Nature (WWF). At the international level, these organizations are among the key stakeholders for their respective areas of interest and perform tasks ranging from advocacy, support of local, national and regional initiatives to research and information dissemination.

The Secretariat included staff from the FAO Fishery Policy and Planning and Fishery Resources Divisions, the FAO Legal Office and the FAO Regional Office for Asia and Pacific, as well as resource persons from the Asian Institute of Technology, and Mahidol and Chulalongkorn Universities, Bangkok, Thailand; Centre for Development Studies, Thiruvananthapuram, India; and Centre for the Economics and Management of Aquatic Resources, University of Portsmouth, United Kingdom.

PROCEEDINGS

The Consultation was opened by Mr Soetatwo Hadiwigeno, Assistant Director-General and Regional Representative of FAO for Asia and the Pacific. Dr Sunil P.P.G.S.N. Siriwardena, Director, National Aquatic Resources Research and Development Agency, Sri Lanka, was elected Chairman and Mr Francisco Nieto-Sanchez, Director , Fomento Acuícola, Dirección General de Acuacultura, Mexico, Vice-Chairman of the Consultation. The Keynote Address was given by Dr Chua Thia Eng, Programme Manager, GEF/UNDP/IMO Regional Programme on Marine Pollution Prevention and Management, Manila, Philippines.

The first one and half days of the Consultation were essentially devoted to an exchange of pertinent information among participants. Government delegates reported on their countries' experiences with shrimp culture development. This was followed by summary results of a literature review on the subject, presentations and position papers by inter-governmental and non-governmental organizations, specific cases studies, and a review of legislation and policies applying to shrimp culture. The written submissions made to the Consultation by delegates and observers from countries, and from intergovernmental and non-governmental organizations will be published in FAO Fisheries Report No. 572, Supplement.

The principal outcome of the Consultation was produced in three working groups whose deliberations were assisted by written discussion guides prepared by the FAO Secretariat. Working Group A addressed legal, institutional and consultative frameworks; Working Group B examined planning and regulatory methods and tools and economic incentives for shrimp culture development and management; and Working Group C discussed the potential role and contents of a voluntary code of conduct for sustainable shrimp culture. The three working groups, whose composition broadly reflected the various interest groups present in the Consultation, were asked to reach a consensus on their recommendations. These were then discussed in plenary for adoption by government delegations and endorsement by observers. All government delegations adopted the recommendations which are partly reproduced and summarized below. There was broad but not unanimous agreement among observers with the report's recommendations.

RECOMMENDATIONS

The first four recommendations constitute a kind of 'Preamble' and, because of their significance, are reproduced in full:

- The Technical Consultation on Policies for Sustainable Shrimp Culture produced a consensus that sustainable shrimp culture is practised and is a desirable and achievable goal which should be pursued.

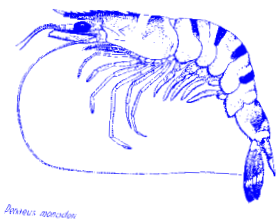
- There is ample reason for considering shrimp culture, when practised in a sustainable fashion, as an acceptable means of achieving such varied national goals as food production, employment and generation of foreign exchange.

- Achievement of sustainable shrimp culture is dependent on effective government policy and regulatory actions as well as the co-operation of industry in utilizing sound technology in its planning, development and operations.

- Appropriate government responsibilities are outlined in Article 9 of the Code of Conduct for Responsible Fisheries. To better implement the provisions of the Code, the Consultation recommended the following.

The first of the above recommendations was adopted after considerable debate and discussion on whether or not sustainable shrimp culture actually existed, or if it is at all feasible. The final wording acknowledges that sustainable operations exist but without specifying how common these are.

Following this 'Preamble', the recommendations are structured along the lines of the findings of the three working groups, some of which are summarized below. The English version of the full report of the Consultation is available on the Home Page of the FAO Fisheries Department (http://www.fao.org/fi) and is being published in both English and Spanish as FAO Fisheries Report No. 572.



Legal, Institutional and Consultative Framework for Sustainable Shrimp Culture

The Consultation recommended that governments should have a legal framework which applies specifically to coastal aquaculture, including shrimp culture, and identified as its objectives the following:

- facilitate and promote the development of sustainable coastal aquaculture practices;
- promote the protection of coastal resources;
- promote the contribution of coastal aquaculture to food security, national and international wise.
- ensure that livelihoods of local communities and their access to coastal resources are not adversely affected by coastal aquaculture developments.

The legal framework for coastal aquaculture should be framed into the whole fabric of laws and regulations, including those applying to coastal zone management, and result from a consultative and interdisciplinary process. It should be sufficiently flexible to respond to short term needs and have a long term orientation contributing to maintaining ecological balance with respect to unforeseen events in future.

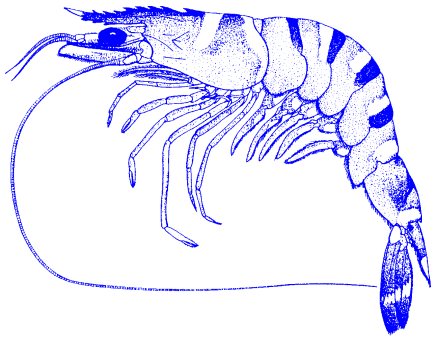
The contents of coastal aquaculture legislation may include:

- a definition of aquaculture;
- provisions on the control and protection of coastal aquaculture: an authorisation process for aquaculture projects; siting of aquaculture projects; protection of coastal aquaculture zones;
- concepts of aquaculture pollution: specific definition, control of aquaculture effluents;
- remedies or compensation systems for damages caused or suffered by coastal aquaculturists; and
- enforcement measures.

Where possible, governments should envisage the establishment of a single aquaculture management authority which would be responsible for the development and management of coastal aquaculture. Where a single aquaculture management authority cannot be created, governments should set up an appropriate administrative framework with the view to ensure co-ordinated development and management.

A specific authority or a procedure is recommended to examine and provide remedies for public grievances in relation to aquaculture activities and their impacts on coastal resources, biodiversity and coastal communities.

The Consultation recommended that relevant international organisations such as FAO should promote and support, where appropriate, the establishment of a legal framework for coastal aquaculture.



Penaeus monodon

Planning and regulatory methods and tools and economic incentive schemes for sustainable shrimp culture

Planning, regulation and the use of economic incentives were all considered important tools to achieve development of sustainable shrimp culture. Shrimp culture should be placed into strategic and coastal zone management planning processes where its role as a legitimate user of coastal resources should be acknowledged. The Consultation stressed the importance of participatory planning and implementation approaches of all stakeholders to ensure the maintenance of local social integrity and rights of local communities.

The consultation recommended that zonal planning for shrimp culture be undertaken as component of integrated coastal area management and take into account, *inter alia*, (a) carrying capacity of the ecosystem, (b) technical and environmental compatibility, (c) social and economic criteria, (d) involvement of local communities and concerned stakeholders, (e) opportunities for integration into other forms of farming practices, (f) effluent and waste management, and (g) provision of appropriate infrastructure.

Recognizing the contribution made by small-scale shrimp farmers to global shrimp production, it was recommended that States should pay special attention to capacity building of the small-scale shrimp farmers through providing adequate technical and financial assistance and extension to improve their culture practices for better productivity and sustainability.

The Consultation recommended a number of specific areas for future research including, in particular, research to determine carrying capacity of coastal ecosystems for shrimp culture with an emphasis on application of this knowledge to local areas. It also recommended exploring economic incentives as a strategy to generate financial resources for promoting and supporting sustainable development of shrimp culture practices.

VOLUNTARY CODES

The Consultation concluded that codes of conduct, codes of practice and guidelines all have useful purposes and should be encouraged. Codes can be useful instruments for reduction of government costs, to promote efficiencies, to provide protection and assurance to consumers and to producers alike, and most important, to help achieve sustainable operations. The Consultation further concluded that the Code of Conduct for Responsible Fisheries, particularly in its sections pertaining to aquaculture, provides an accepted baseline for development of additional codes or guidelines applicable to shrimp culture. Since voluntary codes of conduct or practice specific to shrimp culture can be extremely useful, FAO should encourage their development.

FOLLOW-UP

The Consultation recommended that FAO convene expert meetings to elaborate best practices for shrimp culture, desirable elements of the legal and regulatory frameworks for coastal aquaculture and the criteria and indicators for monitoring sustainability of shrimp culture. Regarding the latter, the Consultation recommended that FAO specifically request governments of countries engaged in shrimp culture to report on progress in implementing the Code of Conduct for Responsible Fisheries in relation to shrimp culture activities to the FAO Committee on Fisheries (COFI) at its next and subsequent sessions . This is seen as a means of encouraging the use of the Code to achieve more quickly full sustainability and to maximize the benefits of shrimp culture.

Furthermore, the Consultation recommended that its report be submitted to the next session of COFI for consideration and endorsement.

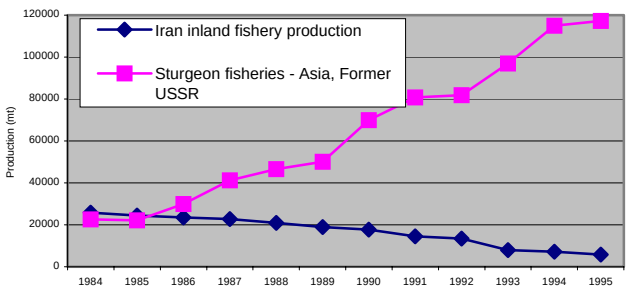
Stocking inland waters of the Islamic Republic of Iran

Devin M. Bartley[1] and K. Rana[2]

[1]Fishery Resources Officer
Fishery Resources Division
[2]Fishery Statistician (Aquaculture)
Data and Statistics Unit

In the last issue of FAN we reported that Drs D. Bartley and K. Rana travelled to the Islamic Republic of Iran on a mission to help Shilat evaluate stocking programmes and the management of aquatic genetic resources in aquaculture. This article reports on some of their findings concerning stocking; findings on aquaculture will be presented in a future issue of FAN.

Figure 1. Inland fisheries of Iran (including aquaculture) and sturgeon fisheries in the region



BACKGROUND

In 1992, the Government of the Islamic Republic of Iran's (IRI) policy for the fisheries, livestock and poultry sectors was aimed at increasing production to meet domestic needs. Today there is also a policy to increase non-oil exports from IRI, as well as a desire to improve the nutritional food security of Iranians through increased consumption of fish. Shilat, the government agency in charge of fisheries and aquaculture, aims to increase per capita fish consumption from the current level of approximately 5kg/yr to 13.5 kg/yr and to increase aquaculture production from approximately 60,000 mt/yr presently to 102,000 mt/yr over the next five years through both direct and indirect assistance. Large restocking programmes for several species of fish in the Caspian Sea and smaller inland water bodies are actively supported by Shilat and play a major role in many fisheries. The purpose of this article is to highlight some of the issues surrounding the stock enhancement practices primarily of the Caspian Sea in IRI.

Although inland fishery production has increased over the long term (Figure 1), an unknown proportion of the increase has been due to large-scale restocking efforts and many of the fisheries may be severely threatened. The fisheries of the Caspian Sea are being heavily impacted by environmental degradation and illegal fishing activities. Extensive oil exploration and extraction are increasing throughout the region. In the past, the Soviet Union was a major regulator of the fisheries in the northern sections of the Caspian Sea. Now however, this regulatory force no longer exists and there are extensive poaching and illegal fishing activities. Many of the Caspian Sea's anadromous fishes, such as sturgeon, Caspian trout, *Salmo trutta caspius*, and mahi sephid, *Rutilus friisi kutum*, can no longer access inland spawning grounds because of riverine water diversion and dam development, and the fisheries are now heavily dependent on stocking.

Sturgeon produce the most valuable fishery product from the Caspian Sea – caviar, estimated to be worth approximately $US 45 million in IRI, but these fishes are very susceptible to overfishing and environmental degradation. In Asia and the former USSR, sturgeon fisheries have drastically declined and illegal harvest has presumably increased substantially. This decline has been seen elsewhere in the world and as a result, all sturgeons are now listed on Appendix II of the Convention on International Trade in Endangered Species (CITES).

STOCKING PROGRAMMES - STATUS

Stocking the Caspian Sea with sturgeon started in Russia in the 1950's and in Iran in the 1970's. Although many of the former Soviet Union hatcheries are no longer producing fingerlings for stocking, in IRI fingerling production for restocking of sturgeon, mahi sephid, and Caspian trout, pike-perch, and bream has increased from around 15 to 196 million from 1978 to 1996; the mahi sephid accounts for the majority of the production (Table 1).

Table 1. 1996 fingerling production from Shilat hatcheries for restocking the Caspian Sea and other inland water bodies. (N = number of fingerlings stocked (millions)).

Species	N
Mahi sephid (*Rutilus frisii kutum)*	142.1
Chinese carp spp	22.7
Sturgeon spp *(Acipenseridae)*	12.5
Rainbow trout (*Oncorhynchus mykiss*)	6.0
Bream (*Abramis brama)*	8.5
Pike-perch (*Stizostedion lucioperca)*	2.4
Caspian trout (*Salmo trutta caspius)*	0.42

There is evidence that the harvest of these enhanced or culture-based fisheries is correlated with stocking intensity and that stocking has, in fact, maintained these fisheries (Abdoulhai, personal communication). The mahi sephid fishery, which collapsed in 1980, has risen from 500 tonnes in 1981 to around 10,000 tonnes in 1996 following restocking from around 400,000 fingerlings/yr in 1981 to around 142 million/yr in 1997 (Figure 2). Similarly, for pike-perch and bream, landings increased from around 5-10 tonnes in 1990 to around 35-40 tonnes in 1996. However, the stocking program-me in IRI is expensive; the cost of running the Shilat hatcheries was reported to be one billion tuman (3.3 million US$, 300 tuman = 1 US$). In addition, little information exists on the biology and ecology of many of the stocked species; levels of natural spawning/reproduction are unknown and difficult to determine because hatchery releases are not tagged.

Shilat is examining the stocking programmes as part of a national programme to increase fish production and conserve valuable aquatic diversity. Other approaches are also being used to manage the sturgeon fisheries in addition to the large scale sturgeon restocking programme. For example, the government has bought back fixed gill nets from 4,000 fisherfolk and trained them to use beach seines at a cost of approximately US$ 10 million. This was deemed necessary because, in addition to the targeted species, these nets also inadvertently trapped juvenile sturgeon and Caspian trout. There is a newly created Sturgeon International Research Institute that has, or is developing, programmes on genetics, nutrition, water quality, physiology, and fish health.

POTENTIAL

The potential to optimise fishery rehabilitation strategies is substantial in IRI based on the following:

- Well developed hatchery facilities for artificial reproduction and larval rearing in several areas along the Caspian Sea shore (Figure 3);
- Increasing capacity in aquaculture related sciences, such as genetics, physiolology, biotechnology, etc (Figure 4).
- Extremely high value of certain fishery products, (caviar);
- Interest from the international community in rehabilitating Caspian Sea fisheries;
- Commitment of Shilat to restore fisheries of the Caspian Sea (Figures 5-7).

Figure 2. Mahi sephid broodstock traps and egg incubators. Broodstock are collected and spawned at riverside. Approximately 90% of migrating adults are intercepted. Photo courtesy of Shilat.

Figure 3. Shaheed Beheshti Fish Propagation and Rearing Complex produces sturgeon and bony fish fingerlings for stocking. In 1997, 9 million 3-5 g sturgeon were produced here. 50-60% of facility is devoted to production of live food for larvae and fingerlings.

The IRI has overcome many constraints to aquaculture and fishery development, but problems persist with rehabilitation of Caspian Sea fisheries. These include:

- Long generation time of key species, such as sturgeon;
- Lack of general awareness of, and extension services for genetic technologies in some areas;
- Extensive activities that immediately threaten the fisheries, e.g. oil extraction, illegal fishing, habitat degradation;
- Lack of regional/international coordination and commitment to the problem;
- Poor information base on stock structure, stock biomass, migration routes, and genetic stock structure of key species; and
- Lack of accurate assessment of alternatives to restocking.

The mission of Drs Bartley and Rana identified some broad activities that could assist in the rehabilitation and conservation of Caspian Sea fisheries:

- Measures to ensure the immediate safety of the resource through *ex situ* conservation are urgently required in light of the numerous threats facing several of these fisheries, e.g. oil pollution, illegal fishing, and habitat loss, and the difficulty in addressing them in a timely fashion for *in situ* conservation. *Ex situ* measures such as gene banks of both live fish and frozen semen can be developed in IRI in conjunction with ongoing activities at the International Sturgeon Research Institute and in the Kelardahst region.

- Efforts should be made to evaluate more rigorously the benefits of the stocking programme; stocking strategies need to be optimised and put into a broader fishery management context that includes habitat protection/rehabilitation, education and outreach, fishery management, and enforcement.

- International workshop on stock rehabilitation in the Caspian Sea should be convened to bring all stakeholder in the region together. Management of sturgeon and other stocks is being hampered by lack of regional coordination and by insufficient data on the population genetic structure and size of the stocks. The extent of the migration routes of many species is not known, therefore it is difficult to determine whether the products of Iranian enhancement are harvested by other littoral States. The States bordering the Caspian Sea are beginning to claim control of their EEZ and this may affect many of the migratory fish stocks that are shared by more than one country.

Figure 4. The capacity of Iranian fishery scientists has improved due to participation in advanced training both in Iran and abroad. Drs Bartley and Rana provided a one day training course on genetic resource management in stocking programmes, aquaculture, and ex situ conservation.

CONCLUDING REMARKS

The release of hatchery-raised fish to maintain or increase fishery production is controversial; if done incorrectly, stocking programmes can endanger wild resources and be a financial drain on the public institutions that support the hatchery. Others feel that stocking is a good means to provide fish in habitats that are affected by development and to increase production from managed water bodies, e.g. reservoirs. Evidence

in the Caspian Sea suggests that stocking has maintained several important fisheries for a number of years. However, the future of these fisheries is uncertain and the IRI is to be commended for its efforts to examine critically the role of hatcheries in fishery enhancement and conservation.

We would like to gratefully acknowledge the assistance of Shilat and especially Mr Maygolynedjad, Mr Abdoulhai, Mr Yousefpor, and Mr Pourkazemi.

Figure 5. The ships sturgeon, A. nudiventris, like many sturgeon, has declined in Iranian waters and efforts to restock and to create genebanks (live and frozen) are underway.

Figure 6. Caspian trout broodstock, collected from Tonekobon River for restocking the Caspian Sea. Two males are used to fertilize eggs from 2 females. Due to cold water temperature fish reach only 10 g in 10 months.

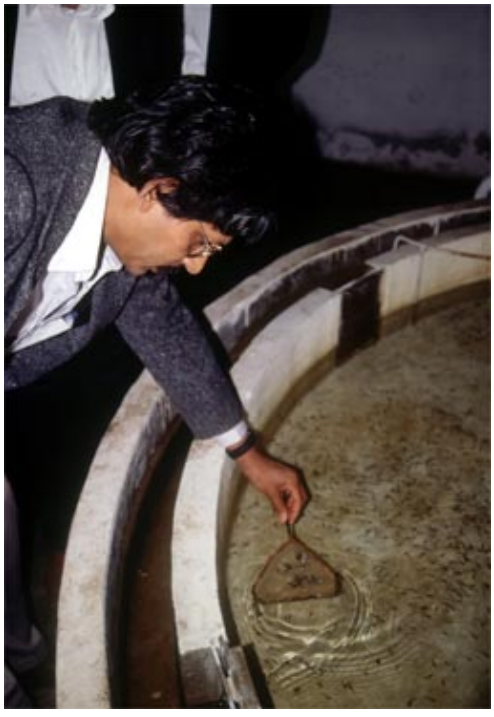


Figure 7. Dr Krishen Rana examining sturgeon fry at Shaheed Beheshti Fish Propagation and Rearing Complex. Larvae begin feeding at about 4 d on live food such as Artemia, daphnia, and oligochaetes. At 60-80 mg, larvae are transferred to earthen ponds and stocked into major rivers at 2-5 g.

Status of Aquaculture in Latin America and the Caribbean

Manuel Martinez[1] and M. Pedini[2]
Fishery Resources Officer[1]
Senior Adviser (Aquaculture Development)[2]
Fishery Resources Division

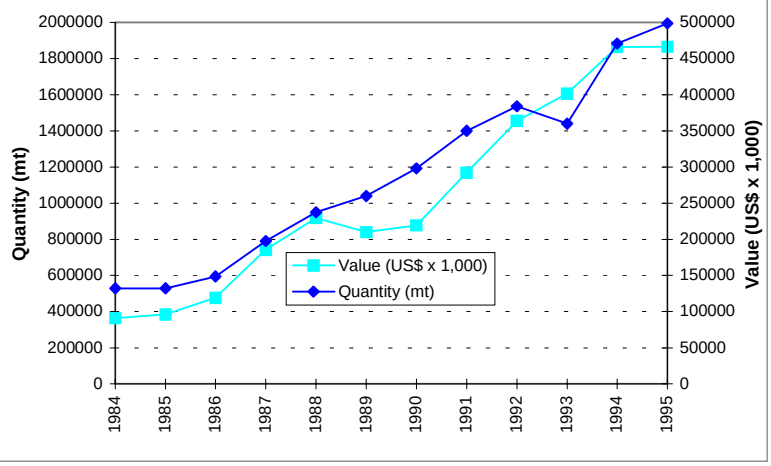
PRODUCTION AND PRODUCTION TRENDS

Aquaculture in this region continued growing steadily during 1984-95, with an APR[1] of 12.8 (Figure 1). Total production in 1995 was 499,000 mt with a value of US$1.87 thousand million, representing 1.8% and 4.4% of world production by volume and value, respectively. In the same year, aquaculture contributed 2.3% in volume to the total production in this region from capture and culture. Production from seven countries accounted for 92% in volume of the total aquaculture production in the region in 1995: Chile (41.4%) and Ecuador (18.3%) were by far the main producers, followed by Mexico (13.8%), Colombia (7.3%), Brazil (6.1%), Cuba (4.2%) and Costa Rica (1.4%) (Figure 2).

Three sub-regions can be clearly differentiated: South America, Central America (including Mexico) and the Caribbean. All the eight countries from Central America (including Mexico), the 14 countries from South America, and 13 out of 23 in the Caribbean sub-region have reported 1995 aquaculture data to FAO.

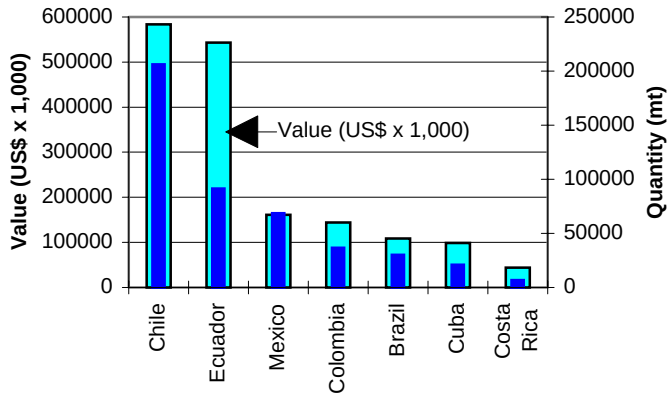
In 1995, production in volume was 378,000 mt (75.8%) in South America, 94,000 mt (18.9%) in Central America, and 26,000 mt (5.3%) in the Caribbean. South America had a rather high APR of 21.8, typical of an emerging activity, during 1984-1988, followed by a lower APR of 15.1 over the next six years, 1990-1995 (but still above the world APR of 12.1 for the same period), as to be expected from an already consolidated sector. Central America had a low APR of 7.1 during the first six years and an even lower APR of 2.2 during the second period, which means that aquaculture has not yet taken off in that sub-region. The Caribbean sub-region shows a similar pattern, with an APR of 6.7 for the 1984-1989 period and an even lower APR, 0.2, for 1990-1995.

Figure 1. Aquaculture trends in Latin America and the Caribbean, 1984-1995



[1]*APR = average percent rate (i.e. average annual compounded growth rate in percent)*

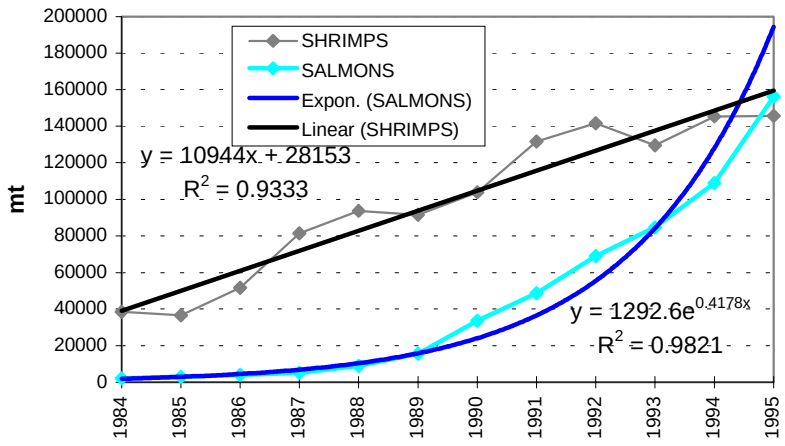
Figure 2. The seven main aquaculture-producing countries in Latin America and the Caribbean, 1995



A specific characteristic of aquaculture in Latin America is that it is mainly export oriented, with shrimp and salmonids as the main export products. Shrimp culture in Ecuador, the main producing country, showed rapid growth during 1984-1889 (APR 16.5) followed by moderate growth during 1990-1995 (APR 3.0).

Culture of salmonids and shrimp, which are exported to the USA, Japan and Europe, accounted for 82.1% of the total value of regional aquaculture production in 1995. Salmonid production in Chile accounted for 28.4% (141,000 mt) by volume and 30.5% by value of total aquaculture production in the region; shrimp production in Ecuador represented 18.2% (90,000 mt) of total regional aquaculture production in volume and 51.5% of total value. The growth in aquaculture production of shrimp during 1984-1995 was linear while that of salmon was exponential (Figure 3).

Figure 3. Trends in production of the two main cultured species groups in Latin America and the Caribbean, 1995



Salmonid culture has developed almost exclusively in Chile with a growth rate superior to any other culture activity in the region (APR 1984-1989, 88.2; APR 1990-1995, 37.7). Production in 1995 (141,000 mt) represented 15.0% of world salmonid aquaculture production. The proportions by volume of production of the three cultured species in 1995 were: rainbow trout (*Oncorhynchus mykiss)*, 37%; Atlantic salmon (*Salmo salar)*, 35%; and coho salmon (*O. kisutch)*, 28%. Salmonid cage farms are concentrated in the southern coast of the country where the lakes for smolt production are also located. The industry has benefited from numerous protected coastal areas, cheap fishmeal derived from the rich anchoveta fishery, and alternate harvesting seasons with respect to European producers. Significant foreign investment has been attracted by these conditions plus cheap labour and a sound political will to develop the sector.

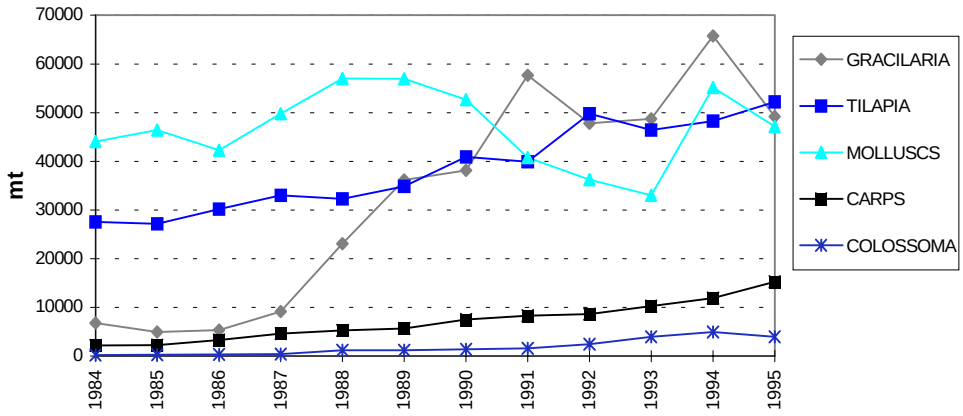
Trout culture, a traditionally stagnant activity in most of the region, has had an impressive growth in Chile from 20 mt in 1988 to 40,000 mt. in 1995. Other countries seem to be following this trend: Colombia with 9,000 mt in 1995, Mexico with 1,500 mt, and Argentina with 1,400 mt.

Shrimp production grew at an APR of 12.8 during 1984-1995. Production in 1995 (146,000 mt) represented 15.6% of world shrimp aquaculture production. The proportions by volume in 1995 of the main cultured species were: white shrimp (*Penaeus vannamei*), 72.0%; and blue shrimp (*P. stylirostris*), 6.8%. In 1995, 11 countries produced more than 1,000 mt of shrimp: Ecuador (62.4%), Mexico (11.0%), Colombia (5.6%), Panama (3.6%), Honduras (3.5%), Peru (3.2%), Guatemala (2.0%), Costa Rica (1.8)%, Nicaragua (1.7%), Brazil (1.4%), and Belize (1.2%).

Shrimp culture in Ecuador started in 1979. Colombia, Brazil, Honduras, Panama and Peru started at the beginning of the 1980s, followed by Mexico in 1985, Costa Rica 1987, Venezuela 1988, and Belize in 1989. Shrimp culture in Latin America has been from the beginning and with minor exceptions an industrial-scale activity.

Production trends of the other five main commodities for the period under review are shown in Figure 4. *Gracilaria* is mostly produced in Chile (49,000 mt in 1995). In 1987, growth of this activity began to accelerate. The growth curve started flattening again in 1992, and since then production has increased very little (APR 1984-1995, 19.7; APR 1990-1995, 5.3).

Figure 4. Trends in production of main cultured groups in Latin America and the Caribbean, excluding shrimps and salmons, 1995



Oysters (*Crassostrea virginica*) account for about 65% of mollusc production in the region. There was a decline during 1989-1993, and although production seems to be recovering, it has not yet reached previous levels (APR 1984-1995, 14.9).

Freshwater fish culture accounted for 19.8% by volume of total aquaculture production in the region in 1995. Culture of red tilapia has experienced the highest growth rate due to the high prices it fetches in export markets. In spite of the enormous existing potential, very few native freshwater fish species are being cultured in the region. Tilapia culture shows a steady increase which seems bound to continue (APR 1984-1995, 12.7). The main producing countries are Colombia, Mexico, Cuba, Costa Rica and Jamaica. This is the main species group cultured at the rural small-scale level. Some important cases of intensive culture are those in Jamaica (2,800 mt in 1995) and Costa Rica (3,800 mt in 1995). The proportions by volume in 1995 of the main cultured species were: *Oreochromis* spp., 43%; *O. niloticus*, 37%, and *O. aureus*, 19.7%.

Production of carps, the main species being *Hypophthalmichthys molitrix* (65%) and *Cyprinus carpio* (21%) as well as production of colossoma (*Colossoma brachypomum* (79%) is the main species of the group) has shown a very moderate growth although they have been present in regional production statistics for more than 15 years. The causes of stagnation in the culture of these promising species are still not clear.

Commercial-scale marine fish culture began in Chile in 1991, and in 1995 turbot (*Psetta maxima*) culture was at the pilot stage. Culture of other marine fish, such as red-drum (*Sciaenops ocellatus*), is entering the pilot phase (in Martinique) but has been commercialized only at the sub-regional level. Other species, still in the experimental phase of culture, include: pompano (*Trachinotus* spp.), snook (*Centropomus* spp.), snapper (*Lutjanus* spp.), mullets *(Mugilidae*), and carangids (*Seriola* spp.). Development of the technology to culture snook is well advanced and this activity is expected to enter the pilot stage very soon. The main problems encountered in marine aquaculture are the scarcity of technologies for local species, the fact that most of the experimental species are carnivorous, and competition with capture fisheries, the products from which are very often low priced.

Main issues

Although there are considerable areas with physical and resource potential, only industrial-scale, export-oriented aquaculture has had significant growth in the region; and this type of activity still has a moderate potential for growth. Other kinds of aquaculture, such as of molluscs, aquatic plants and freshwater fish, as well as rural aquaculture and aquaculture-based fisheries in reservoirs, have grown at a rate slower than expected,

considering their potential and the economic needs of the countries resulting from recent trade and finance conditions. Most of these forms of aquaculture are oriented toward domestic markets. The difficulties encountered in promoting aquaculture for domestic markets in the region are not linked to existing physical resources, but mainly to institutional factors, as well as to research and entrepreneurial capacity. With very few exceptions, aquaculture in the region is not properly integrated into government structure and policy frameworks. In addition, structural adjustment policies have reduced the governments' capacity to promote and develop aquaculture oriented towards the production of cheap products for the poor. Competition with inland fisheries production is sometimes a serious hindering factor for aquaculture development.

Trends towards shrimp culture intensification have decreased in recent years due to disease problems. During 1992-1995, Ecuadorian shrimp culture was affected by increased incidence of disease (mostly Taura Syndrome virus), which caused drastic production drops. Measures taken to avoid this problem have included stocking at lower densities, less feeding and less water pumping. The epidemic initially promoted diversification, because some farms that were closed by the virus started culturing *Cherax* spp. and finfishes such as tilapia and redfish, as well as polyculture of shrimp and tilapia. This tendency slowed down when the Taura Syndrome virus impact decreased.

Latin America has about 11 million ha of water surface in reservoirs. It is estimated that present production through fisheries and aquaculture-based fisheries in these water bodies represents only a small percentage (about 12%) of its potential. The main constraints for this development are managerial and very much linked to institutional problems.

In general, freshwater culture in the region is making little use of alternative ways to increase production such as through fertilization, polyculture and integration with other farming systems. The prevailing technology uses expensive and sophisticated high energy-consuming methods: high stocking densities, exclusive use of commercial feed, and methods to increase the carrying capacity of the ponds, such as aeration and strong water exchange. Apart from any social concern, a monoculture technology based on the stocking of fingerlings that are fed with expensive commercial feed and harvested for export markets, does not seem to be an economically sustainable activity for small-scale rural farms.

In summary, aquaculture development in the region is hindered by problems which can be grouped in the following categories:

Environmental. Problems mostly related to industrial-scale aquaculture are beginning to arise. Mangrove cutting in Ecuador, and conflicts with capture fishery activities in several countries, mainly due to alleged destruction of larval resources, are some of the consequences of culture intensification and faulty farm site selection.

Climatic. Events such as El Niño, which has had impact on the shrimp culture industry on the Pacific coast of the region through floods and undesirable changes of temperature, and hurricanes in the Caribbean area, are important concerns for aquaculture farms.

Biological/technical. Diseases are affecting not only shrimp culture (viral) but also oyster culture (parasites), and in many cases, there is no known treatment. The reproductive cycles of several aquaculture species are also not fully understood. Seed supply is a serious limiting factor in many areas, affecting industrial, semi-commercial and rural aquaculture.

Institutional and legal framework. There has been delayed reaction to developments in the aquaculture sector.

Social. These problems are related to land tenure, conflicts on the use of certain resources, access to aquaculture products by the poor, and personnel (processing workers, larvae collectors, etc.).

Economic. Instability, frequent currency changes, high inflation rates, high commodity prices and competition with capture fisheries are some of the main economic problems.

OUTLOOK

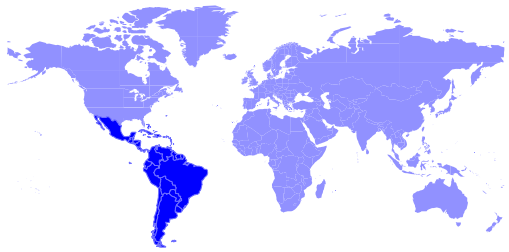
The Latin America and Caribbean region has been characterized by macro-economic changes in the last two decades. Even in recent years, fluctuations in currencies and inflation rates in some of the major countries have created difficulties for investment in aquaculture, still a relatively new industry in the region. Mid- and long-term projections for aquaculture production are therefore particularly speculative, and this paper will only attempt to provide an outlook for the short-term scenario, 1995-2000. The more recent APRs for countries and species provide some guidance on how aquaculture production may evolve in the region.

Aquaculture growth in the Caribbean has stagnated in the last five years due to the Cuban crisis. This country strongly influences projections for the sub-region as it contributed over 78% of Caribbean production in 1995. The rest of the countries seem to have reached a situation of slow growth. The Cuban government is committed to invest in aquaculture development for food security reasons, and is investing in new stations. Growth rate of the sector may be expected to increase markedly, although the targets established in 1996 for the year 2000 appear to be too optimistic. A production of 60,000 mt per year by 2000 would be a very good result and would bring the annual total for the Caribbean to about 70,000-75,000 mt. This growth is likely to be due to culture of tilapias in more intensive systems and to the farming of Chinese carps. An expansion of crustacean culture in the Caribbean, mainly for export, will also see Cuba as the main producer.

Central America had a low APR in 1990-1995 due to the poor performance of the sector in Mexico, which contributed 72% of the production of this sub-region. The outlook for Central America is a relatively fast growth of shrimp culture on the Pacific coast due to the combined efforts of Mexico, Guatemala, Honduras, Nicaragua and Panama. Shrimp culture has taken off in these countries since 1990 with APRs ranging from 9 to 104 in 1990-1995, and this growth is expected to continue, disease epidemics permitting. It is likely that future growth may accelerate with a more important contribution of shrimp culture to the total production than at present. Mexico has potential for areas to be developed, already-established marketing channels for export, and investment programmes that have been recently promoted by the Government with assistance of the World Bank. All this suggests favourable growth prospects, in spite of the complex institutional situation which may be an impediment to rapid growth. A contribution of about 70,000 mt of cultured shrimp by year 2000 for Central America is not unreasonable (an APR of 15 for 1995-2000), and a similar output could be expected for other commodities (APR 4), bringing the total to 140,000 mt per year by 2000.

In South America, the major prospects for expansion of production are with salmonids, shrimp, tilapia and *Gracilaria*. Salmonid culture is concentrated in Chile, which produces 90% of the sub-region's total salmonid production, and has recorded APRs ranging from 27 to about 80 for the three major species. Prospects for APRs in the order of 20 in the short term may even be conservative considering the advantages of the country for salmonid production, and the fact that it is already an established industry. Projected overall annual salmonid production of the sub-region by the year 2000 would be about 350,000 mt. Shrimp production is mainly in Ecuador (84% of the total output), but the growth rate in 1990-1995 slowed down to an APR of about 3 due to the saturation of areas under culture and the incidence of diseases. Future prospects may not be very different from present rates and will be based on sustainable extensive/semi-intensive farming practices, and measures to control diseases. However, other countries of the sub-region such as Venezuela and Brazil may experience much faster growth of shrimp culture due to the availability of suitable areas and the stagnation of supply at the world level, which could encourage investment. An annual total of about 140,000 mt could be expected for year 2000 at an APR of 5. Tilapia culture is one of the fastest growing sub-sectors, pushed by the availability of export markets and the introduction of intensive production packages. Production is concentrated in Colombia and Venezuela and this situation is expected to remain stable up to year 2000. A conservative APR for these two countries of around 30 would mean an annual production level of about 67,000 mt by year 2000. *Gracilaria* culture is also concentrated in Chile and is expected to stabilize at about 65,000 mt annually by 2000, although the extensive nature of the production and the climatic variation in the sub-region may produce considerable variations in output from year to year.

Overall, the contribution of the major cultured groups is expected to increase the supply of aquaculture products, mainly oriented to export, from the 330,000 mt (87% of the total production) in 1995 to about 622,000 mt by 2000. Adding the rest of the species farmed, total annual regional aquaculture production could be expected to be about 690,000 mt by year 2000.



PROJECTS AND OTHER ACTIVITIES ...

Mario Pedini
Senior Development Adviser (Aquaculture)
Fishery Resources Division

Meeting of GESAMP Working Group 31 on Aquaculture and Coastal Management

The **GESAMP** Working Group 31 on Environmental Impacts of Coastal Aquaculture held its Third Session during 1-5 December 1997, in Bangkok, to review concepts and experiences related to the integration of aquaculture into coastal area management schemes. The Working Group addressed a wide range of issues pertinent to coastal aquaculture development, coastal management, as well as experiences and concepts related to efforts of integration. It decided to synthesise its findings and conclusions to provide guidance to readers on available technical information, and on options for initiating or strengthening actions for planning and managing coastal aquaculture development in relation to existing or possible coastal management efforts. The WG's draft study report will be presented to the 28th Session of GESAMP (Geneva, 20-24 April 1998), for discussion and approval for publication in the series of *GESAMP Reports and Studies.*

First Session of the Committee on Aquaculture and Inland Fisheries (AIFIC) of the Asia-Pacific Fishery Commission (APFIC)

This session, which was originally scheduled for November 1997, was postponed to mid 1998 due to the lack of quorum. The invitation to the countries has been dispatched with the indication that the rescheduled meeting would take place from 13 to 16 July 1998. The provisional agenda of this first session of the AIFIC includes: reviews of the status of inland fisheries and aquaculture in Asia and the Pacific, based on a synthesis of national reports; fisheries in food security in Asia and the Pacific (policy issues and policy measures); rural aquaculture, starting with focus on a proposed framework for country reviews; intra-regional cooperation; the future role and activities of the AIFIC for which the countries are requested to take into consideration FAO's on-going efforts to (i) formulate technical guidelines for the implementation of the Code of Conduct for Responsible fisheries, (ii) implement the Special Programme for Food Security, (iii) develop or facilitate the elaboration of information systems to support development and management of the sub-sectors, and (iv) to facilitate follow-up on identified aquaculture development research priorities.

FAO/NACA Workshop on Aquaculture Information Systems In Asia

A three days workshop will take place at the NACA headquarters in Bangkok from 11 to 14 May 1998 to initiate discussion on the possibility of establishing an Asian Aquaculture Information System. The meeting, to which a selected group of representatives of Asian countries and regional and sub-regional agencies will be invited, will:

- review the result of a survey of existing data bases and aquaculture information systems conducted by the FAO in major aquaculture producing countries in Asia,
- discuss the perceived needs of the participating countries and agencies for aquaculture information systems,
- present the aquaculture information systems which the FAO is implementing in the Mediterranean under the aegis of the Committee on Aquaculture of the General Fisheries Council for the Mediterranean, and
- discuss an action plan for follow-up work and for collaboration with other agencies of the region for the implementation of the action plan.

The meeting will be jointly sponsored by the FAO and NACA, which has repeatedly indicated interest in the development of aquaculture information systems.

Second Meeting of the IOFC Gulfs Committee *Ad-Hoc* Working Group on Aquaculture

The second session of the Indian Ocean Fisheries Commission/Gulfs Committee *Ad Hoc* Working Group on Aquaculture is being convened in Kuwait from 18 to 21 May at the premises of the Mariculture and Fisheries Department of the Kuwait Institute for Scientific Research. The provisional agenda of this meeting, which follows a previous session in Cairo, Egypt, in October 1996, includes the following points: (a) the establishment of an aquaculture information system, including a follow up work plan and schedule, (b) confirmation of the research priorities identified in the First Meeting and identification of related intersessional activities, and (c) reports/technical papers on advances in aquaculture research and development, including progress in the application of the Code of Conduct for Responsible Fisheries.

Strategy for International Fisheries and Aquatic Research (SIFAR), Support Unit

Following previous recommendations of the Fishery Development Donor Consultation, a new Support Unit for the Strategy for International Fisheries and Aquatic Research (known previously as SIFR - Strategy for International Fisheries Research) has now been set up alongside the Fisheries Department at FAO, Rome.

The role of the SIFAR Support Unit is to facilitate the identification and funding of research proposals from national institutions and other responsible bodies in member countries. Although not in itself a funding source, the SIFAR Support Unit will nevertheless provide the necessary linkage between donors and recipient organizations. This should ensure that proposals are developed in a manner that meets respective technical and policy requirements, and are presented in formats considered appropriate for donor funding.

Although the Unit will be working primarily in collaboration with all of the Fisheries Department's technical services, it is attached administratively to the International Institutions and Liaison Service, Fishery Policy and Planning Division. Furthermore, in order to reinforce its cross-sectoral role, the Unit will develop strategic linkages with other FAO Departments and the various Regional and Sub-Regional offices.

The Unit became operational on 1 March 1998 with the arrival at FAO of Mr. Tim Bostock who takes up a new appointment as Deputy Executive Secretary, and will be acting as Executive Secretary until this post is filled, possibly later on this year. With funding from the Department for International Development (DFID), he will be working with the Unit on secondment from the UK's Natural Resources Institute (NRI). Mr. Bostock has extensive practical and managerial experience in the field of fisheries research and development. Having spent 13 years working overseas with several DFID-funded fisheries initiatives in Latin America and south Asia (Bay of Bengal Programme), he has more recently been undertaking a variety of short-term consultancy activities in Africa with NRI, as well as a long-term assignment as Co-ordinator of an EU-funded fisheries project in Mozambique. Since 1995, he has held the post of UK Co-ordinator for the UNDP/GEF Lake Tanganyika Biodiversity Project.

The task now begins of transferring to FAO the existing background knowledge and experience from the previous SIFR Secretariat based in IDRC, Ottawa, Canada. The Unit is financed by contributions from a range of bilateral and multi-lateral donors. Contributions are also received in kind.

For further information, please contact:
Mr Tim Bostock
Deputy Executive Secretary
SIFAR Support Unit
Fisheries Department, Room C646/7
FAO, Viale delle Terme di Caracalla
00100 Rome, ITALY
Telephone: (06) 5705 4606 (SIFAR Unit)
(06) 5705 5959 (Tim Bostock, direct)
E-mail: SIFAR-Support-Unit@fao.org
Tim.Bostock@fao.org (direct)

Evaluation of Project CUB/91/005 "Development of Intensive Shrimp Culture in Cuba"

In 1997, UNDP requested FAO to organize a mission to evaluate the results of the above mentioned project. The mission was carried out in September 1997 by an international Consultant, Mr. C. Berger and a national expert, Mr. Alfredo de la Cruz. This project was a follow-up of CUB/86/004, implemented by FAO, for the improvement of culture techniques of the local species *Penaeus schmitti* and development of the shrimp culture subsector. By the end of this project, in

1990, Cuba had developed a total of 2 000 ha of shrimp ponds and produced 1 200 mt. Shrimp postlarvae were produced in hatcheries which had an installed capacity of 570 million PLs. The objectives of the CUB/91/005 were: to increase production through intensification to an average of 3 mt/ha/year in two to three cycles; to automate management controls to improve all phases of the cycle; and to develop appropriate diets for the various culture stages. The project should have resulted in a production of 5 200 mt at the end of the project, in 1995.

The project was nationally executed, and implemented through the Empresa Nacional de Camaronicultura (ENC) and later through the Asociación para el Cultivo del Camarón (CULTICAM). The area of the project was the southern part of the island in the provinces of Cienfuegos, Sancti Spiritus, Camagüey, Las Tunas and Granma. The project started in April 1993 and concluded in July 1997. It suffered during its implementation from the drastic changes which took place in the Cuban economy, in what has been called locally the "special period", resulting in reduced investment in the subsector. As a result of these changes, the project management revised the production strategy to adapt it to the new situation, in general adopting methods requiring less inputs. The main activities carried out concern experiments on intensification and diet formulation; as well as training of technicians; development of infrastructure and purchase of equipment for grow-out facilities and hatcheries; and informatization of the production process.

Project evaluation was generally positive, although not all the expected results were achieved. The country has benefited from the training imparted through the project and from the availability of equipment for production. Management of the project was considered to be of good standard. The output in terms of expected production was not achieved, but the mission was of the opinion that production targets were excessively optimistic, as they did not take into account the financial viability of proposed models. As a result of the activities of this development project, Cuba has acquired a better understanding of shrimp culture in terms of sustainability and financial viability. The mission recommended to UNDP that, for future similar projects in areas where there is limited experience, prefeasibility and feasibility analysis be implemented, inorder to identify viable production scenarios. In the case of Cuba, this would mean to consider more semi-intensive practices, to promote growth of natural food in the ponds, as well as different feeding strategies and changes in the harvest strategies. The mission also recommended the use of external assistance when new technologies were to be introduced.

Assistance for Responsible Movement of Live Aquatic Animals

A new regional TCP project TCP/RAS/6714 of two years duration has been approved for the Asian region to assist in the area of movement of live aquatic animals. The project, which is to be implement through the Network of Aquaculture Centres for Asia-Pacific (NACA), has already started operating. Disease outbreaks are becoming increasingly recognized as a significant constraint to aquaculture production. In 1990 the losses in developing countries of the Asian region were estimated at no less than US $ 1 400 million, and in 1993 in China alone the losses in shrimp farms amounted to about US $ 1 000 million. Recent estimates based on farms surveys in 16 Asian countries suggest losses in the order of US $ 3 000 million. Movements of live aquatic organism are considered to be an important factor in the spread of diseases in Asia. This has prompted the Asian countries to request assistance to improve regulatory and technical measures (as recommended in Article 9, on Aquaculture Development, of the Code of Conduct for Responsible Fisheries).

The Immediate Objective of this new project is to develop national and Asia Regional Technical Guidelines on Animal Quarantine and Health Certification for the safe and responsible transboundary movement of live aquatic animals. The expected results of the project are: the development of national technical guidelines on quarantine and health certification for 19 countries; formally agreed and standardized Asia Regional technical guidelines on quarantine and health certification of live aquatic animals; and improved capacity of national aquatic animal quarantine and health certification authorities in 19 Asian countries to exchange information on aquatic animal pathogens, disease outbreaks epizootics, standardized diagnostic procedures, and control and preventive measures. The project workplan is divided in six phases, the first one from December 1997 to January 1998 for the establishment of an Information Base, the second phase (February 1998) dealing with provision of training and establishment of information collection procedures, the third phase (March to April 1998) for the installation of computer facilities and start of the data/information collection. The fourth and key phase (till June 1999) will include the analysis of information collected and the drafting of the technical guidelines. The guidelines

will be revised in the fifth phase (July to August 1999), while the sixth phase (September 1999) will be devoted to the adoption of the technical guidelines.

FAO will provide international experts and consultants on computer networking and data base development, aquatic animal health information systems and epidemiology, and aquatic animal health certification and quarantine. In addition, personnel of the FAO Fisheries Department will be directly involved in the implementation and backstopping of the project. The FAO will assist with equipment (computers) and with liking the new network to the Internet. Funds will also be provided for regional and national (China and India) training. The project also receives some technical and financial assistance from a number of national, regional and international institutions and agencies such as Office International des Epizooties (OIE), UK Department for International Development (DFID), and the Governments of Japan and Australia.

NACA will contribute to the project by assuming all administrative, planning and implementation responsibilities, providing physical facilities and secretarial services, and will assume responsibilities for maintaining the Internet links once the project is concluded. NACA will also be responsible for the preparation and distribution of publications.

Third Technical Coordination Meeting of the South Pacific Aquaculture Development Project (Phase II), GCP/RAS/116/JPN

The Third Technical Coordination Meeting (TCM) of the SPDAP II took place from 20 to 22 November 1997, in Nadi, Fiji with participation of delegations from Fiji, Kiribati, Nauru, Niue, Palau, Samoa, Solomon Islands, Tonga, and Vanuatu. The meeting was also attended by ICLARM, the Canada-South Pacific Ocean Development Programme II, South Pacific Project Facility, University of South Pacific, Tonga/ JICA project, Overseas Fishery Cooperation Foundation of Japan, the donor agency: the Fisheries Agency of Japan, representative of the FAO RAP office in Bangkok and resource persons.

This project had started operations in April 1994 and is scheduled to terminate in mid 1999. It is assisting 15 island nations of the South Pacific in their effort to develop sustainable aquaculture as a contribution to their food security. The main purpose of the TCM was to review the progress of the project and to formulate the work plan for 1998/99.

The activities carried out since August 1996 on a species basis were:

Tilapia culture: assistance to restocking programme in Samoa; taste test in Samoa and Nauru; assistance to development of commercial culture and marketing information in Fiji; organization of workshop/training in Fiji and organization of a study tour.

Milkfish farming: training and demonstration in Tuvalu and Nauru; assessment of milkfish as bait for tuna fishing in Fiji; organization of workshops/ training in Tuvalu and Fiji; organization of study tours and distribution of information materials to all countries.

Freshwater prawn culture: the project supplied postlarvae to Fiji.

Seaweed farming: assistance to Fiji, Samoa, Tonga and Kiribati in marketing surveys; collaboration with the University of South Pacific on the culture of sea grapes and red algae; brown algae stock survey in Tonga; organization of a workshop/ training on seaweed farming in Kiribati and on seaweed handling in Tonga; and distribution of information materials to the member countries.

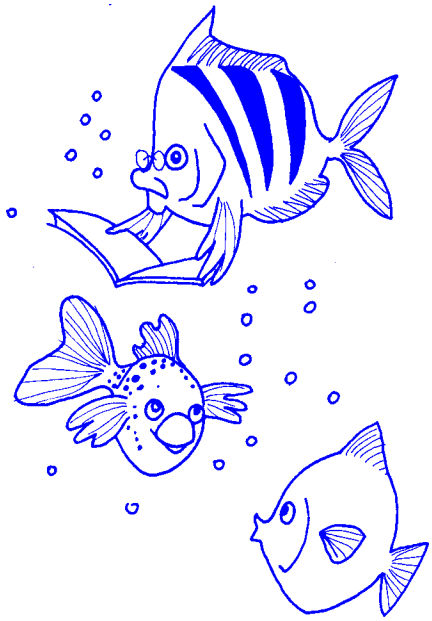
Mollusc culture: exploring possibilities for joint ventures on Mabe pearl farming in Tonga and Palau; site selection for green snail culture in Samoa; marketing studies on giant clam meat; surveys and restocking of trochus in Niue, Cook Islands, and Kiribati; study tours and training on green snail restocking; a regional training course (jointly with JICA) on green snail seed production and stock enhancement; pearl farming and distribution of information material on giant clam culture and on pearl production.

In addition, the project obtained CITES clearance for Solomon Islands and Tonga; organized and held a workshop on Marketing of Aquaculture Commodities; assisted Fiji in the relocation of the freshwater aquaculture center; and collaborated with ICLARM and SPC in setting up a self supporting mechanism for the development of aquaculture in the region.

The proposed plan of work for the remaining period of the project was drawn according to the seven project objectives, with special emphasis on the specific needs and current status of aquaculture development in the 15 member countries of the project.

NEW FAO PUBLICATIONS

Ziad H. Shehadeh
Senior Fishery Resources Officer
Fishery Resources Division



FAO. 1997. Review of the state of world aquaculture. *FAO Fisheries Circular,* No. 886, Rev. 1. Rome, FAO. 1997. 163p.

The circular updates the regular review of world aquaculture, based mainly on national statistics provided to FAO bits Members through 1995. The review is prepared in three parts. The first provides a global perspective of production and production trends, and the contribution of the sector to food fish supplies. It identifies some of the major strategic issues facing aquaculture development and presents a rough estimation of production by the year 2 000. The second part reviews developments and trends in some important fields, including environmental interactions, biodiversity and genetics, feed resources, fish health and quarantine, regulatory frameworks, product safety, international trade, and international aid to research and development. The third part reviews production and production trends, as well as main development issues and outlook on a regional basis, for each of seven regions: Asia, Africa, Former USSR Area, North America, Latin America and the Caribbean, and Oceania.

Charles, A.T.; Agbayani, R. F.; Agbayani, C.E.; Aguero, M.; Belleza, E.T.; Gonzalez, E.; Stomal, B. and Weigel, J.Y. 1997. Aquaculture economics in developing countries: regional assessments and an annotated bibliography. *FAO Fisheries Circular,* No. 932. Rome, FAO. 1997. 396p.

As aquaculture expands in importance globally, there is an increasing need for corresponding information, to aid managers, policy-makers and planners. This document seeks to provide a review of the current state of the aquaculture economics information and research base in developing countries, based on a comprehensive compilation of available literature on the subject. A broad integrated view is adopted, encompassing micro- and macro-economics, market analysis, socio-economics and environmental economics, the relationship with non-aquaculture economic activities (household economics), as well as relevant socio-cultural considerations. The circular contains two principal components. First, there is a set of regional assessments (Africa and the Middle East, Latin America and the Caribbean, Asia and the Pacific) reviewing the economics of aquaculture activity, the state of the art in aquaculture economics research, and research priorities for the future, on a region-by-region basis. Second, a set of annotated bibliographies is provided, one for each of the three regions, together with a bibliography of general references. In total, 1 154 references are included: 77 general; 223 for Africa and the Middle east; 133 for Latin America and the Caribbean; and 721 for Asia and the Pacific. Each bibliography documents available literature on the economics of aquaculture systems, emphasizing the most recent literature, but also including older literature as relevant to the current state of aquaculture. All bibliographies are indexed according to country, aquatic species, production environment, production system and eight economic subject areas.

Rana, K. J. 1997. Guidelines on the collection of structural aquaculture statistics. Supplement to the Programme of the World Census of Agriculture 2 000. *FAO Statistical Development Series*, No. 5b. Rome, FAO. 1997. 56p.

The Census of Agriculture is a large scale national statistical operation for collecting quantitative information on the structure of the countries food production sector. The new programme for the World Census of Agriculture 2 000 (WCA 2 000 Programme) recommends extending the scope of the programme to include aquaculture. This Supplement on aquaculture is intended to assist countries to improve their current surveys of aquaculture and to provide a framework for those countries intending to develop databases on aquaculture information. Its four chapters provide background information on the need for the Supplement and definitions, concepts, standards and guidelines for collecting internationally comparable data on aspects such as location and size of the farms, types of aquacultural activity, employment structure, resource use and other aquacultural inputs. The items proposed for collection address issues related to natural resource utilization and sustainable aquaculture development issues. The Supplement also provides examples of summary tables which could be used to develop a questionnaire. Also included are relevant notes from the main WCA 2 000 Programme and the species classification list for farmed aquatic species used by FAO.

FAO. 1997. Pêche et aquaculture au Proche-Orient et en Afrique du Nord: situation et perspectives en 1996. *FAO Circulaire sur les Pêches* No. 919. Rome, FAO. 1997. 39p.

This is the French version of the Circular of the same number, published in 1996 (see *FAN* 15: 33-34). It presents a detailed analysis of the state of fisheries and aquaculture in the region, one of eight such regional studies carried out for the preparation of *The State of World Fisheries and Aquaculture* (see *FAN* 16: 27). The contents were described earlier in *FAN 15*, page 34.

FAO. 1997. Inland fisheries. *FAO Technical Guidelines for Responsible Fisheries*, No. 6. Rome, FAO. 36p.

This is yet another of a continuing series of guidelines published by the Organization to facilitate the implementation of the Code of Conduct for Responsible Fisheries. Inland fisheries differ from most other fisheries forming the subject of the Code in their high degree of inter-relatedness with other users of the aquatic resource. In most areas of the world the principal impacts on fisheries do not originate from the fishery itself but from outside the fishery. Consequently most aspects of the Code directed at the conservation and sustainability of the resource are under the control of a wide range of superior social and financial implications for society. Implementation of the provisions of the Code in these cases is more a question of negotiation and consultation with these interests. The fishery has to be managed within the constraints imposed by these external sectors and, while there is space for conventional management of the fishery as such, much attention is paid to techniques for mitigation or rehabilitation of external impacts. Inland fisheries are increasingly sharing the problems of aquaculture in that there are attempts in many fisheries to deliberately influence the composition of the fish assemblages in favour of societal goals. These introduce concepts of sustainability which correspond more to agriculture than to conventional capture fisheries, and here interpretation of some articles of the Code has to be liberal.

Sugunan, V.V. 1997. Fisheries management of small water bodies in seven countries in Africa, Asia and Latin America. *FAO Fisheries Circular*, No. 933. Rome, FAO. 1997. 149p.

The current interest in small water bodies derives mainly from their utilization for fisheries enhancement, which involves guidance on stocking, exploitation and species management in order to obtain optimum yield on a sustainable basis. This Circular contains the results of an attempt to probe into the national experience in management of small water bodies in selected tropical countries with a view to gauging the resource size and assessing the strengths, weaknesses and issues involved in their management from a global perspective in order to facilitate bilateral or multilateral interaction among nations displaying similar characteristics. The Circular provides an overview of the small water bodies and their fisheries in southern Africa, Asia and Latin America, represented by Zimbabwe, India, Thailand, Sri Lanka, Brazil, Cuba and Mexico. It depends heavily on the secondary data collected from various government agencies of the countries. A main constraint has been the remote and nondescript nature of the resources, the details of which, if available, were scattered among a number of agencies. Nevertheless, major facets of fisheries management in small water bodies in the seven countries have been highlighted. The main emphasis was on the resource size,

organization of fisheries management and species management, depending on the availability of data and information. An endeavour has also been made to offer policy prescriptions of operational significance for streamlining the fishery management of small water bodies, particularly the reservoirs and other man-made impoundments which have promising fishery potential.

FAO/DFID. 1997. Report of the Expert Consultation on Inland Fishery Enhancements. Dhaka, Bangladesh, 7-11 April 1997. *FAO Fisheries Report*, No. 559. Rome, FAO. 1997. 18p.

The potential for enhancement of fish production from inland waters is a priority activity of the Inland Water Resources and Aquaculture Service of the FAO Fisheries Department. Recognizing the high significance of the enhancement of fisheries for its member countries, FAO, in close collaboration with the Department for International Development of the United Kingdom (DFID, UK), organized an Expert Consultation on Inland Fisheries Enhancements in Dhaka, Bangladesh, from 7 to 11 April, hosted by the Government of Bangladesh. The consultation was attended by 42 participants from 13 countries. The major objective was to promote better understanding of how the various technical, socio-economic, cultural and administrative factors involved in implementing inland fisheries enhancements programmes must fit together to achieve success. The key conclusions were that: (i) enhancements of fisheries resources are likely to be accompanied by changes, (ii) significant production increases and associated benefits are possible via enhancements, but resource limitations and institutional constraints are likely to moderate the pace of enhancements; (iii) proper resource management of the fishery and the ecosystem, often through the use of traditional systems, is necessary to maintain the resource equilibrium that is needed for long-term sustainability; (iv) governments need to recognize both traditional and non-traditional approaches prior to the formulation of new fishery laws and regulations; and (v) institutional constraints are equal to or greater than technical limitations.

CIFA. 1997. Report of the sixth session of the Sub-Committee for the Protection and Development of the Fisheries in the Sahelian Zone. Accra, Ghana, 21-24 July 1997. *FAO Fisheries Report*, No. 567, Accra, FAO, 1997. 32p.

This document is the final formal report of the Sixth Session of the Sub-Committee for the Protection and Development of the Fisheries in the Sahelian Zone of the Committee for Inland Fisheries of Africa (CIFA). Major topics discussed were: the contribution of fisheries in man-made lakes and irrigation dams to food security in the Zone; the current status of fisheries development and management in the Sahelian countries and the contribution of aquaculture to fish production in the Sahel; future of the CIFA Sub-Committee for the Protection and Development of the Fisheries in the Sahelian Zone and the sub-regional project proposal for management planning of Sahelian fisheries. The report provides information on the main decisions, directives and recommendations of the session.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). 1996. The contributions of science to coastal zone management. *Reports and Studies, GESAMP*, No. 61. Rome, FAO. 1996. 66p.

The scope, objectives and defining features of Integrated Coastal Management (ICM) are briefly described and a conceptual framework for the effective operation and evolution of ICM programmes is presented. ICM programmes have the dual goals of conserving the productivity and biodiversity of coastal ecosystems while improving and sustaining the quality of life of human communities. This requires the active and ongoing involvement of the interested public and the many sectoral groups with interests in how resources are allocated, development options are negotiated and conflicts mediated. Selected case studies from a diversity of settings in developed and developing nations reveal striking commonalties in the interplay between science and ICM and demonstrate that effective ICM cannot occur in the absence of science. The natural sciences are vital to understanding the functioning of ecosystems, and the social sciences are essential to comprehending patterns of human behaviour that cause ecological damage and to finding effective solutions. Scientists and resource managers often have different perspectives and imperatives, but need to work together as a team and reach agreement on the scientific work needed to address priorities and guide policy development. The case studies also underscore that programmes must tailor their scope and objectives for a given period to the capabilities of the institutions involved.

Mr. Jiansan Jia Assumes Post As FIRI Chief

Mr. Jiansan Jia has been appointed Chief of the Inland Water Resources and Aquaculture Service (FIRI) of the Fishery Resources Division and took up his duties at FAO headquarters in Rome, Italy on 16 March 1998. A Chinese national, he gained his M.Sc. in aquaculture from the University of the Philippines in Visayas in 1982.

Mr. Jia worked for the Ministry of Agriculture in Beijing from 1986 to 1988, as Director of the Division of External Economic Relations, Bureau of Aquatic Products. In this capacity, he was responsible for promoting cooperation in fisheries with other countries and international organizations and was directly involved in externally funded aquaculture development projects. Subsequently (1988-1993), he was Deputy Director-General of the Bureau of Aquatic Products, Ministry of Agriculture (MOA), in Beijing, where he participated in the formulation of national development policies of the fisheries sector, with emphasis on aquaculture development. From 1993 to 1994, Mr. Jia served as Vice General Manager of the China National Fisheries Corporation in Beijing, with full responsibility for the aquaculture-related business of the company. Thereafter he was first Deputy Director-General and then Director-General a.i. of the Department of International Cooperation, (MOA) in Beijing for the period 1994-98. Here, he supervised and coordinated bilateral and multilateral cooperation with various governmental and international organizations in the fields of agriculture, animal husbandry and fisheries.

In January 1998 he was appointed General Manager of the China National Agricultural Livestock/Fishery Corporation in Beijing, where he implemented the technical assistance programmes provided by the Government of the People's Republic of China to developing countries in the fields of agriculture, animal husbandry and fisheries.

Mr. Jiansan Jia (left) with Mr. Moritaka Hayashi, Assistant Director General (Fisheries)

Mr. Jia is a member of the Asian Fishery Society, the China Society of Fisheries, the International Institute of Fisheries Economics and Trade, and the North Pacific Marine Science Organization, as well as a member of the editorial boards of a number of scientific journals.

Mr. Jia is the first service chief of FIRI with a predominantly aquaculture background. His extensive experience in shaping the aquaculture sector in the People's Republic of China (PR China), is a major asset for FIRI and the Fisheries Department in general. The PR China accounted for 63% of global production from aquaculture in 1995, as well as 27 % of global landings from inland capture fisheries. It is also largely responsible for the high global growth rate of aquaculture. At a time when many countries are increasingly looking to aquaculture to help maintain per capita fish supplies, Mr. Jia's appointment is both timely and appropriate. We bid him welcome and look forward to working with him in furthering the development of sustainable aquaculture and inland fisheries.