1. INTRODUCTION

Although capture fisheries currently provide most of the aquatic production for human consumption, aquaculture will become more important as capture fisheries decline or stabilize. World fish production from all sources in 1999 was 137 million t, including 43 million t from aquaculture and 94 million t from capture fisheries. Aquaculture production more than doubled between 1990 and 1999 (from 16.8 million t in 1990 to 42.8 million t in 1999; FAO 2000a), while capture fisheries production increased only marginally (from 86.8 million t in 1990 to 94.1 million t in 1999; FAO 2000a). Aquaculture has become the world's fastest growing food-producing sector, with a growth rate of 10% annually since 1984. Asia produces about 91% of the world's total aquaculture production, with China, India, Japan, the Republic of Korea, the Philippines, Indonesia and Thailand as top producers within Asia.

Freshwater aquaculture is a major source of growth not only for aquaculture but also for the whole Asian fishery sector. Asian countries are the major suppliers of freshwater aquaculture products (Table 1). World production of freshwater fish from aquaculture was 19 390 284 t in 1999 with China contributing about 73% of this. Other major contributors from Asia during this period are India (9.90%), Bangladesh (2.60%), Viet Nam (2.10%), Indonesia (1.49%), Thailand (1.32%) and the Philippines (0.50%). It is worth noting that while the contributions of Bangladesh, China and Viet Nam to world freshwater fish production are increasing, contributions from India, Indonesia, the Philippines and Thailand are gradually declining. As far as annual growth rate of freshwater aquaculture fish production is concerned, Viet Nam achieved the highest annual growth rate (15.97%) followed by China (13.86%), Bangladesh (11.70%), Thailand (10.85%), and Indonesia (4.70%) during the 1989-99 period. In the Philippines, the sector achieved a very negligible annual growth rate (1.18%) during this period.

Freshwater aquaculture benefits poor rural communities in many developing countries, enhancing food security and improving the livelihoods of poor people. It is against this background that a study dealing with the production, accessibility, marketing and consumption patterns of freshwater aquaculture products in Asia is both timely and important.

The broad objective of the present study is to examine production, accessibility, marketing and consumption patterns of aquaculture products, with emphasis on freshwater aquaculture, in Bangladesh, China, India, Indonesia, Philippines, Thailand and Viet Nam. Specifically, the study addresses the issues of production, accessibility, consumption, marketing and demand for freshwater aquaculture products to determine the requisites for sustainable and equitable development of the industry in Asia.

The study is organized in seven sections. Following the introduction, the second section gives a brief overview of the data and methodology used in this study. Section three reviews the fisheries sector and trends of freshwater production, the contribution of aquaculture and fishery in general to Gross Domestic Product (GDP) and some country-specific development policies are briefly discussed. These policies often influence markets and access, export earnings, local consumption and priority policy action for the development of the industry. The fourth section is a brief discussion on the socio-economics of fish producers, including an overview of modes of operation, production systems, farm ownership, farm sizes, species composition, inputs used, productivity and profitability. The fifth section presents and discusses fish consumption pattern and preferences, levels and trends of fish food protein intake in relation to other protein sources, and price and income elasticities. This is followed by an overview of fish marketing, the role of credit, retailing practices and constraints to access to credit in the sixth section. The final section is a summary and conclusion, with recommendations on realizing the potential of the freshwater aquaculture sector in Asia.

2. SOURCE OF DATA METHODOLOGY

The primary data used in this study were a combination of the producer and consumer field surveys carried out by the International Center of Living Aquatic Resources Management (ICLARM-The World Fish Center) and its partner institutions under the “Dissemination and Evaluation of Genetically Improved farmed tilapia in Asia” (DEGITA) and the “Genetic Improvement of Carps Species in Asia” projects, conducted during the periods 1995-1996 and 1998-1999, respectively (ICLARM, 1998 and 2000). Complete details of the sampling and data collection procedures, as well as the instruments used in both the surveys are provided in Dey *et al*. (2000) and ICLARM (2001), respectively. In addition to primary data, secondary data sources from country reports, published literature, FAO databases (for various years), reports and publications and Asian Development Bank indicators were also compiled. In examining demand for fish in general and freshwater species in particular in these countries, elasticities from previous studies (Dey, 2000a, Chern, 1997; Chern and Wang, 1994; Huang and Bouis, 1996; Estrada and Bantilan, 1991; and Bhatta, 2000) were compiled and presented.

3. SECTOR REVIEW

3.1 The role of the fisheries and aquaculture sector in the economy

The common objectives of the fisheries sectors in the countries concerned are to increase production and export earnings, and to create employment opportunities. The governments of these countries have intervened in the aquaculture sector through various sector-specific policies on feed, fertilizer, trade, investments and research. Dey and Bimbao (1998) reviewed most of these sector-specific policies. This section focuses on the development plans and thrust that the governments of these countries formulated for the development of aquaculture. It starts with a review of the freshwater fisheries sectors and their contribution to the countries' economies.

All the countries studied have significant agricultural sectors contributing between 17% (China) to 28% (Viet Nam) to the GDP (Table 2). The fisheries sectors contribute between 1.59% (Indonesia) to 10% (China) of the GDP. While agriculture's contribution to GDP is generally declining, the contribution of the fishery sector is increasing, except in Thailand. The importance of the fisheries sector to China's economy is inextricably linked to the country's overall scientific and technological progress, and the energetic support and favourable policies set by the government to develop the aquaculture industry (Cen and Zhang, 1998). Direct employment provided by fisheries sectors range between 1 million in the Philippines to 36 million in China. Information on employment benefits from aquaculture in particular is not well documented (Shang, 1990) but one can generalize that it only represents a small proportion of the total labour force in agriculture. However, it is valuable as a source of supplementary employment and income for rural women and young people. The aquaculture sub-sector of most of these countries has three major components - brackish water, freshwater and mariculture. Most of the aquaculture has developed in freshwater environments.

3.2 Review of development policies

In Bangladesh, the major thrust for the development of fisheries includes, among others: culture and capture fisheries; promotion of rice-fish farming systems in the vast floodplains; and conservation and management along with institutional and manpower development for equitable distribution of benefits from common property water resources. (Alam, 2000). The major objectives for development of the fisheries sub-sector during the fifth plan period (1997-2002) were as follows: (a) to generate additional employment opportunities in fisheries and ancillary industries to help poverty alleviation; (b) to increase fish production and improve nutritional levels; (c) to improve the socio-economic conditions of fishermen, fish farmers and others engaged in the fishery sub-sector; (d) to increase export earnings from shrimp, fish and fish products; (e) to improve environmental conditions; (f) to improve the biological and institutional management mechanisms for judicious use of fisheries resources; (g) to strengthen research, extension, management and coordination in order to transfer technology and encourage production activities in the private sector and to ensure sustainable development of the resources of the vast floodplains.

There are over 1.3 million ponds covering an estimated area of 147 000 ha, some 6 000 ha of ox-bow lakes and over 130 000 ha of shrimp farms. Currently, the average production in fresh water ponds is 1.4 t/ha and that of brackish water shrimps farms only 160 kg/ha. During the period of the fifth plan, all 1.3 million ponds will be brought under extension programmes of the Department of Fisheries, the Fisheries Development Corporation, the Fisheries Research Institute and NGOs.

China's fisheries policy used to be guided by overall policy regulations. Until the late 1970s, the state sector used to dominate the supply side (production, procurement and rationing to

consumer) of the fishery economy. This dominance was broken by reform that started in 1979, in favour of market development.

Decollectivization, price increases, and relaxation of trade restrictions on most agricultural products fuelled China's food economy's take-off (1978-84). It was in this period that aquaculture started drastically outpacing fish capture production. The fishery sector enjoys the benefit of early reform in market and price liberalization because it was considered a less risky element, or a non-strategic food commodity, in the nation's food security system. Price and marketing liberalization policy has had a sharp influence on the growth of aquatic production. Favourable output to input price ratios contributed to the rapid growth of aquaculture in both the early reform and the late report periods. The higher incentive of aquatic production has been provided by gradually increasing aquatic product output prices. The area of aquaculture increased from 3 million ha in 1981 to nearly 4 million ha in 1985 and over 5 million ha by the mid-1990s. With the expansion of both yield and area, total aquaculture output reached 20.3 million t, fifteen times higher than that of 1980 output.

As in the agriculture sector, technological change is one of the sources of aquaculture growth in China (Huang and Qiao, 2000). Technological breakthroughs include: (a) development of artificial propagation technology for fish, shrimp and crabs; (b) development of high-yielding technology in pool fish culture; (c) development of fencing culture technique and fish propagation protection in lake fish culture; (d) adoption of net-boxing technology in reservoir fish culture; (e) successful breeding and cross-breeding of some high-value species and introduction of exotic species; (e) development of multiple-ingredient feeds and their commercialization; (g) disease control; and (h) development of fishery science. The economic reforms increased competition tremendously, resulting in substantial improvement in productivity and production of aquatic products.

In the past, India had followed highly protective trade policies for agriculture, including fisheries. With the exception of a few traditional commodities, agricultural trade was subject to measures such as quantitative restriction, canalization, licences, quotas and high tariff rates. The Indian constitution provides for a federal structure within the framework of a parliamentary form of government. The fisheries and aquaculture sectors, within the broader framework of agriculture, are governed by state administration. The Ministry of Environment and Forests of the Government of India ban capture of some of the exotic species such as tilapia, catfish, etc., which have good potential for the enhancement of production.

Thailand's macro-policy pertaining to aquaculture is to increase fisheries production from aquaculture at the rate of 5% per year. Freshwater aquaculture is intended mainly for domestic consumption, while coastal aquaculture is both for domestic consumption and export. The policy objective is to be achieved through: (a) increasing production efficiency by improving management and culture techniques; (b) improving the environmental compatibility of aquaculture production systems; and (c) developing and rehabilitating the infrastructure needed for the expansion of production and trade.

The Department of Fisheries, together with the Network of Aquaculture Centers in Asia-Pacific (NACA), drafted the Thai Aquaculture Development Plan for the year 2001-2020. The Plan aims to increase the role of aquaculture, maintaining the importance of low-input aquaculture as a protein food supplier for domestic consumption, and at the same time, developing a highly competitive, sustainable aquaculture industry to meet consumer demand for cultivated aquatic products that are safe, high quality, competitively priced and nutritious, and produced in an environmentally responsible manner with maximum opportunity for profitability in all sectors of the industry for export.

Several development goals have been formulated. The first is to make the Thai aquaculture industry competitive in a global market place through: (a) increased efficiency and profitability of aquaculture production systems; (b) improved aquaculture production systems; (c) improved sustainability and environmental compatibility of aquaculture production; (d) assured quality and safety of aquaculture products; (e) improved marketing of aquaculture products; and (f) improved technology transfer, information dissemination, and access to global information and technology in aquaculture. The second development

goal is to reduce the fisheries trade deficit and increase exports through increased aquaculture production. The third goal is to ensure that the development of aquaculture contributes to job creation and growth of the Thai economy. Other goals are to ensure that the industry's long-term development is sustainable and compatible with responsible environmental stewardship; to provide Thai consumers with domestically produced, high quality, safe, competitively priced and wholesome aquaculture products; and to develop information for and educate consumers and retailers about the nutritional composition, characteristics, proper handling, presentation, and preparation of aquaculture products' species and varieties. Likewise, it is also important to establish and maintain world leadership in basic science in support of Thai aquaculture development, enhance partnerships in support of aquaculture within governmental agencies, among local and governmental agencies and the private sector, and encourage aquaculture's contribution to the enhancement, protection and maintenance of public and private aquatic resources. It is also important to evaluate the potential for development of alternative aquaculture species, production systems and markets, and to evaluate options for improving the regulatory framework for aquaculture in support of both commercial and public sector aquaculture development.

In the Philippines, the government intervenes in the freshwater aquaculture sub-sector through various specific policies on feed, fertilizer, trade, investment and research. For feed, the government has been following an import substitution policy encouraging the use of local ingredients to reduce the cost of feed. As a means to improve the competitiveness of the country's aquaculture products in the export markets, tariffs on feeds and feed ingredients have been lowered to reduce the prices of local as well as imported feed. Feed imports are not subject to quantitative restrictions. The government also plays an active role to ensure the availability and use of fertilizer for aquaculture. Fertilizer prices are set under government controls, raw materials are provided to factories at subsidized prices, companies are permitted to participate in foreign trade, etc.

Aquaculture trade policies are focused mainly on the promotion and protection of tradable export commodities, such as seaweed and shrimp. Moreover, the country maintains an open-trade policy, with no quantitative restrictions for those willing to engage in the export, import and local trade of aquaculture commodities. Entry is also non-restrictive as long as all legal requirements are met. Favourable incentives are given to exporters, whereas importers are penalized by high tariff rates. The country has open-entry investment policies to encourage local and foreign investors to engage in a wide range of aquaculture activities to sustain and enlarge the sector's contribution to the national economy. The priority investment areas are: the upgrading of production and hatchery systems; establishing additional feed mills and modernizing existing processing plants and machinery; strengthening infrastructure facilities, such as roads, transportation, communication, power and ports; and improving skills, technological knowledge and transfer of technologies through research and development.

Recently, the Congress of the Philippines enacted an important law, the Philippine Fisheries Code of 1998 (R.A. 8550) to develop, manage and conserve the fisheries and aquatic resources of the country. Earlier, another law, the Agricultural and Fisheries Modernization Act (R.A. 8435) or AFMA, was passed to revive, modernize and develop the agriculture and fisheries sectors (Congress of the Philippines 1997). These two laws are significant to development of aquaculture because they explicitly recognize the conservation, protection and sustained management of resources as a major objective in the fisheries sector (Israel and Roque, 1999; Olalo, 2000).

4. THE SOCIO-ECONOMICS OF FRESHWATER FISH FARMERS

Discussions in the sections below are supported by the results of the DEGITA producer and consumer field survey and the carp improvement project conducted during 1995-1996 and 1998-1999, respectively (ICLARM, 1998 and 2000). Specifically, information for the Philippines was extracted from the DEGITA project while the information for the rest of the countries under study was extracted from the carp project. This section opens with a brief discussion of the socio-demographic profile of freshwater fish farmers in selected Asian countries.

4.1 Profile of freshwater fish farmers

A socio-demographic profile of Asian fish farmers is presented in Table 3. The average age of fish farmers ranges between 43 and 52. Average level of education ranges from 4 to 12 years. Chinese farmers in general had the highest level of education (12 school years). The percentage of illiterate farmers appears to have varied between 2% (Thailand) to as high as 33% (India). Crop farming is the main occupation of the majority of the fish farmers in Bangladesh, Thailand and India, ranging from 41 to 65%. The high percentage of fish farming as a primary occupation in India (43%) is due to the high percentage of households (95%) that were fully dependent on fish culture in Andhra Pradesh, one of the sampled states. However, in many other states, such as Orissa and Uttar Pradesh, fish culture is still at a subsistence level. Fish culture as a main occupation is lowest in Viet Nam (2-4%), followed by Bangladesh (9%) and Thailand (20%). Fish farms are more of a subsistence nature in Bangladesh and Viet Nam, and to some extent in Thailand, where it has mainly developed as a rural activity integrated into existing farming systems. In Bangladesh, some ponds were used for various purposes (bathing, washing, etc). The farmers sampled in China were engaged in fish farming as their primary source of income.

Except for fish farmers who are engaged in cage culture, sample respondents have considerable fish farming experience, ranging from five to 15 years across the selected countries. In general, most Southeast Asian countries have had a long tradition of aquaculture (De Silva 1996). This is one of the main reasons why Asia has remained the leader in aquaculture production, and its dominance is also on the increase.

Except in Viet Nam, fish farming is mostly carried out by the male, who is head of the family. In Viet Nam, female participation is as high as 56% in the North and 50% in the South, indicating that carp farming is an occupation that can be undertaken by women. Participation of women in aquaculture activities in Asia has been on the increase in general. While fish farming is in fact highly dominated by men (with 95% male participation), in fish trading sex discrimination is less apparent. Women share fish farming activities such as fish rearing, with men. In Bangladesh, women are not usually permitted to do a range of fieldwork or to go to the markets and thus have some spare time for fish husbandry (Williams 1996). Information dissemination and training schemes on flexible technological choices have significantly enhanced women's participation, as well as productivity and rate of technology adoption (Ahmed, 1997; Ahmed *et al*., 1995; Gupta and Rab, 1994). Shaleesha and Stanley (2000), report that in fresh and brackish water aquaculture, women in India are engaged in carp polyculture, breeding and nursery raising, breeding of catfish and freshwater prawns in backyard hatcheries, ornamental fish breeding and culture of *Spirulina* and *Azolla*, net-making and mending, and feed preparation of carps and prawns. While in Thailand, the Philippines and India, women are more actively involved in fish marketing and processing than in producing. In some cases women also carry out and participate in fish culture and fish operations. Fish processing activities are undertaken either individually or as a family enterprise, while fish marketing is done by individuals, usually by wives of fish farmers. In urban communities, the

involvement of women is mostly in marketing either as a broker/wholesaler and/or as a retailer.

The income structure shows that the average gross household income of Chinese fish farmers (US$ 17 321) was highest among the selected countries, followed by Thai farmers (US$ 11 272). The average gross income of state-owned, collective and cooperative farmers are US$ 149 135, US$ 184 963 and US$ 53 179, respectively. In general, the gross household income of fish farmers is above the national average income. Fish culture contributes as much as 80% in India and as little as 15% in Bangladesh. The contribution of carp farming to total income in India varies considerably between the states. It is only 15% in Orissa and 95% in Andhra Pradesh.

4.2 Freshwater fish production systems

Polyculture in ponds is the dominant production system for most of the selected countries. In China, production from ponds accounts for 77% of the total inland aquaculture production (Ye, 1996). Pond culture covers 1.86 million ha, or about 40% of the total available area and registered 74% of the total yield in 1995 (Cen and Zhang, 1998). Thailand, the Philippines and China have considerable practices of tilapia monoculture in cages. Monoculture and polyculture in tanks is also observed among fish farmers in the Philippines and India, respectively. Polyculture in paddy fields (rice-fish system) is also common in Bangladesh, China, Thailand and Viet Nam and to some extent in the Philippines. In addition, the fish culture development schemes in these countries (especially Thailand and Viet Nam) have been designed to fit into the socio-economic conditions of the rural populace and wherever possible, people are encouraged to culture fish in addition to pig or poultry raising and other agriculture activities. Cage and pen culture is almost negligible in Bangladesh and India, while these are quite considerable in Thailand, China and the Philippines. Farmers in Indonesia practise rice-fish farming over a wide area (1 700 000 ha of paddy). FAO reported that about 78% of Indonesian farming households cultivate fish in small ponds of less than 500 m, and aquaculture is the main source of income for 66% of the households that cultivate fish in the paddies and ponds. Potential production of freshwater aquaculture in Indonesia consists mainly of the use of fish in irrigation systems (about 4 million ha) and in about 1% of the open-water area of 14 million ha which consist of lakes, reservoirs, rivers and swamp (Kontara and Maswardi, 1999). Advanced rearing systems were developed in 1972 with the introduction of running water ponds, raceways, cages, floating net cages and pen culture (Jangkaru, 1981; Kontara and Maswardi, 1999) in these open-water bodies.

4.3 Effective land area

The average total area cultivated per household is as high as 4.91 ha for pond owners in the Philippines and as low as 1.04 ha in southern Viet Nam (Table 4). In China, family-based households operate only 3.60 ha on average, while state-owned, large-scale farms are as big as 131 ha. Cage owners in the Philippines owned 1.26 ha of land on average, of which 43% is used for fish culture. The area allocated to the fish pond is 32% in northern Viet Nam, followed by 31% in the Philippines, 24% in India and 26% in Thailand. On average, the size of the fish pond is bigger in China (1.70 ha) followed by the Philippines (1.56 ha), Thailand (1.21 ha) and northern Viet Nam (1.16 ha). The average size of the fish pond is only 0.20 ha in Bangladesh, because these ponds are basically natural water bodies used for various purposes along with stocking.

4.4 Ownership

Except in China and northern Viet Nam, the freshwater farms are mostly family-owned and members of the family assist in the operations. In China and northern Viet Nam, a considerable proportion of farms are state-owned or under collective ownership. Also in China and the Philippines, large-scale operations exist which rely heavily on farm managers or caretakers for operations. State owned freshwater fish farms in India (30%) are usually common water bodies owned by the state Irrigation Department and used by the Fisheries Department for stocking. Joint ownership is common in India, Thailand and Viet Nam.

4.5 Type of operation/farming duration/rearing type

In Indonesia, it takes only three to four months to rear carps in running water systems, while it takes eight to 12 months in Bangladesh, China and India. A considerable number of ponds in Bangladesh, India and Viet Nam are seasonal in nature. This is due to the seasonal floods that are common in these countries where farmers do not culture fish during these periods.

4.6 Water depth

The average water depth of the fish ponds during the dry season is as low as 0.93 m in southern Viet Nam and as high as 2.90 m in India. During the wet season, farmers maintain higher water levels in India (4.78 m). Cages in the Philippines have a minimum water depth of 4.20 m and 5.60 m on average during dry and wet seasons, respectively.

4.7 Composition of species, stocking density and sources of fingerlings

Although species diversity is vast in these countries, cultured species are limited in number. Bangladesh and India have Indian major carps (*Labeo rohita, Catla catla* and *Cirrhinus mrigala*) as the dominant cultured species (Table 5). In India, 70% of the total aquaculture production is contributed by Indian major carps (FAO, 1997).

There are over 40 freshwater species cultured in China (Cen and Zhang, 1998). The production survey of the carp project (ICLARM, 2000) showed that the major species include Chinese carps such as silver carps, common carps, grass carps and crucian carps. Production of the top three species - silver carp (3.71 million t), bighead (2.07 million t) and grass carp (1.4 million t) - collectively accounted for about 76% of national freshwater aquaculture in 1995. It should be noted, however, that China also cultured tilapia both in pond mixed with carps and monoculture in cages (Dey *et al*., 2000; ICLARM, 1998).

Tilapia is the dominant freshwater aquaculture species in the Philippines. Though production statistics show that milkfish and carps are available, milkfish is not widely cultured in freshwater fish ponds as compared to tilapia. Carps, on the other hand are considered as a newcomer. Due to its limited volume, the production statistics for carp species are lumped together with those for other species and it is only recently that the country started to keep a track of the production performance of carp species. Though production of carp is not even 1% that of tilapia, an average annual growth rate of 55% for freshwater pond production was achieved during 1993-1997 (Olalo, 2000)[1]. Carp has very strong potential to be a major fish to culture in the near future in the Philippines.

Thailand has a different kind of dominant cultured species like tilapia, Thai silver barb, walking catfish, snakeheads and common carp. Tilapia accounted for over 33% of the total cultured freshwater fish during 1997 and has become increasingly popular in every region in the country due to its fast growth and easy culture (Piumsonbun, 2000). Nile tilapia, walking catfish, Thai silver barb, “sepat siam”, striped catfish and striped snakehead contributed nearly 90% in quantity and over 75% in value during the period. Production of all the species mentioned, except “sepat siam,” increased significantly, particularly Thai silver barb, walking catfish and tilapia, which increased at average annual rates of 24%, 20% and 18%, respectively, during 1977-1997. Common carp is the dominant freshwater species produced in Indonesia, cultured in running water systems under monoculture and in paddy fields. Production in 1995 was 152 790 t, which contributed 55% of total freshwater fish production (Kontara and Maswardi, 1999). In Viet Nam, while rohu and silver carps are common in the north, common carp and silver barb are the dominant fresh water species in the south. Tilapia is also cultured throughout the country.

Stocking density is high in Bangladesh (10 300 pcs/ha) and India (18 400 pcs/ha) in relation to the amount of other inputs. On the contrary, China and Thailand stocked much more per hectare of water area (27 900 pcs/ha in China and 67 300 pcs/ha in Thailand) along with relatively higher use of supplementary feed and fertilizer.

Most of the fish farmers in China produce their own fingerlings. In Bangladesh and India, fingerlings are available from private and public hatcheries and from intermediary fingerling

traders. Private hatcheries have a monopoly on fingerlings in Viet Nam - only about a quarter of the sample respondents in northern Viet Nam produce their own fingerlings. In the Philippines, cage operators get their fingerlings from private hatcheries. Pond operators in the Philippines and Indonesia obtain fingerlings from private and government hatcheries.

4.8 Input use and yield

Along with stocking density, inputs such as supplementary feeds and fertilizers determine the level of intensity of a given farm. Fish farmers practising intensive culture use complete feed with proportionally more protein and less carbohydrate content than for semi-intensive and extensive culture (Panayotou *et al*., 1982; Edwards, 1993 and Tacon, 1997). Table 6 shows the level of inputs used and the yields of different culture systems in the countries under study. Farmers in Bangladesh, India and Viet Nam use relatively less supplementary feed and other inputs in fish farming as compared to farmers in China and Thailand. The inputs used suggest that most of the farms in Bangladesh and India are extensive. In China, on the other hand, there are no extensive farms - most farms practise at least semi-intensive production. Dey *et al*. (2000) reports that freshwater cage culture in China is highly intensive. In the Philippines, extensive, semi-intensive and intensive operations co-exist. In Indonesia, running water systems are basically semi-intensive and intensive systems, while rice-fish systems are extensive (Kontara and Maswardi, 1999). For the running water systems and cage culture systems, heavy input dependence was on fingerlings, feed and labour. On the other hand, pond culture systems used various types of inputs, such as fingerlings, feed, fertilizer, chemicals, pesticides and labour. Average stocking density in ponds was between 10 300 to 136 400 pcs/ha. For pond culture systems, feeding was given in terms of commercial feed, rice bran, oil cake and other forms of feed. Both organic and inorganic fertilizers were used. Lime was only used in Bangladesh and Thailand.

Yields vary considerably among countries. This can be attributed to the variation in production intensity levels, production environments, farming systems and culture practices. China showed significantly higher yields than those of Bangladesh, India, Thailand and northern Viet Nam.

In India, production is best examined by state due to the differences between states in terms of farming practices and culture. Veerina *et al*. (1993) reported that in some parts of India, particularly in Andhra Pradesh, where 94% of the fish ponds were previously used for shrimp culture, farmers have successfully adopted semi-intensive production practices with average annual yields of 6-8 t/ha using organic and inorganic fertilizers and plant-based diets such as rice bran, cottonseed meal, de-oiled bran and groundnut cake as supplementary feeds. In general however, carp yields in India and Bangladesh were relatively similar. Yields in Thailand and northern Viet Nam are also relatively similar and are higher than those of Bangladesh and India. For Indonesia, cages produced significantly higher yield than running water systems.

4.9 Costs and returns, productivity and profitability

The costs and returns are expressed in US$, based on the exchange rates for local currencies during the survey period (1998-1999 and 1995-96 for the Philippines). Even though there are numerous concepts for determining the profitability of fish culture operations, this paper simply defines different profitability concepts depending upon types of costs deducted from gross revenues. Hence, profitability of freshwater fish production was measured in terms of operating profits, rates of return over variable costs and ratio of operating profit to variable. As fixed costs are not available from other countries, only variable cost was included in cost and return analysis. Data from China and Thailand shows that fixed cost accounted for about 10% of the total cost. Dey *et al*. 2000 reported that fixed cost in freshwater culture in these countries accounted for between 9% and 35% of the total cost. In Bangladesh and Viet Nam, as fixed cost is relatively unimportant (McConnel and Dillon, 1997), the used of gross margin is considered as a good measure of profitability (Dey *et al*., 2000).

Table 7 reports the cost and return/profitability of freshwater fish production. As for yield levels, the costs and returns of fish production vary widely due to differences in production environments, input levels, culture practices and farming systems. The average freshwater farm in participating countries had total receipts ranging from US$ 1 715.12/ha (Bangladesh) to US$ 10 797.11/ha (China) for ponds. Running water systems and cages in Indonesia had total receipts of US$ 506.89/100m^2 and US$ 872.97/100m^2, respectively.

Operating profits per hectare per production cycle were highest in China (US$ 3 448.08) followed by Thailand (US$ 1 470.70) and northern Viet Nam (US$ 1 398.57) and lowest in India (US$ 589.31). In the Philippines, operating profits in tilapia monoculture during 1995-96 were as high as US$ 1 326/ha per production cycle for ponds and US$ 495.20/100m^2 per production cycle for cages. Positive operating profits shown by freshwater fish production ensures continuation of operations in the short term, providing that fixed assets cannot be liquidated without undue loss or switching to another farming activity is not be possible. Prospects for freshwater fish production over the long term can be seen by inclusion of fixed costs in calculating the profit.

Rate of return over variable cost is close to 150%, except in Bangladesh, Thailand, northern Viet Nam and cage culture in the Philippines, where the rate was over 200%. Cost per unit of output (or break-even price) implies that the country who has the lowest cost in producing a unit of output (US$/kg) is the most productive and cost effective. In this context, since the cost per unit of output and the unit output price is lowest in Bangladesh and Thailand, farmers from these countries are considered as more productive and cost effective than the farmers in other countries.

The levels of productivity and cost efficiency in Indonesian carp production were found to be unexpectedly low during the study. This may be due to the fact that the survey was done during the peak recession period when the farmers did not have the capacity or could not afford to purchase adequate inputs necessary for better production. For cage culture, Dey *et al*. (2000) showed that farmers who are engaged in tilapia cage culture in China are more productive and cost effective than cage farmers in the Philippines.

Feed costs were significant for pond operation in China and Thailand, where they account for about 46% and 33% of the total costs, respectively. Feed costs were equally important for Indonesia's RWS and cage systems, accounting for more than 50% of total costs. In Bangladesh and India, feed only accounts for 14% and 16% of the total costs, respectively. In all countries except India, the share of fingerlings to total cost is lower than the share of feed. This indicates that high feeding rates seem to compensate for low stocking rates. In general, it can be said that high yields correspond to high stocking and feeding rates. Commercial feed was used in minimal quantities, except for in China and Thailand.

It should be noted that freshwater farming is considerably more risky than other types of farming activity. The carp producers' survey (ICLARM, 2000) included both successful and unsuccessful farms, giving clear evidence of the socio-economic risks involved. In most cases, fish farmers are considered risk averse. The use of polyculture and integrated culture systems shows not only the profit maximization behaviour of fish farmers, but also that they are risk averse. To reduce costs on feed, they use various types of feed, such as rice bran, kitchen waste and oilcake.

4.10 Total factor productivity

The productivity measures used above, such as yield, operating profit, rate of return and cost per unit output, are biased due to the fact that differences in prices (both input and output) among the countries involved are not accounted for. To compare productivity measures taking into account the differences in input and output prices, we used the total factor productivity (TFP) indexes, specifically the interspatial Tornqvist index (TI). Following Dey *et al*. 2000, interspatial TI is defined as:

$$TI_{ij} = Ln\left[\frac{Q_i}{Q_j}\right] - \frac{1}{2}\sum_k Ln\left[\frac{X_{ki}}{X_{kj}}\right](s_{ki} + s_{kj}) \qquad (1)$$

where:

TI_{ij} = Interspatial Tornqvist Index,

Q_i = Output quantity of country i,

X_{ki} = Quantity of input k in the production process of country i,

s_{ki} = kth input cost share of country i.

The exponentiation of TI_{ij} gives the productivity difference between two countries (i.e. country i and country j). The equivalent dual cost index can be expressed as:

$$-TI_{ij} = Ln\left[\frac{C_i}{C_j}\right] - Ln\left[\frac{Q_i}{Q_j}\right] - \frac{1}{2}\sum_k (S_{ki} - S_{kj})Ln\left[\frac{P_{ki}}{P_{kj}}\right] \qquad (2)$$

where

C_i = total cost of production for country i,

P_{ki} = prices of input k in country i.

The exponentiation of $-TI_{ij}$ in equation 2 gives the productivity differences of two countries in terms of cost, indicating how much more or less it would cost a particular country (say country i) compared to another (say country j) to produce the same quantity of output per unit area. We first estimate the dual cost index and then the production (primal) index is calculated by negating the dual cost index. To correct for differential product/species combination in various countries, production value is used in addition to production quantity as a measure of output in equation 2 to calculate the interspatial Tornqvist indices.

Table 8 summarizes the results of total factor productivity. TFP indices were computed for polyculture ponds for Bangladesh, China, India and northern Viet Nam using Thailand as the base for comparison. The table shows that only farmers from Bangladesh had incurred lower costs per hectare (30%) and at the same time lower yields (27%) than farmers in Thailand. Farmers in India, who incurred 76% higher costs per hectare than farmers in Thailand, had 9% lower yields in terms of production value and 15% lower in terms of production quantity. Farmers in northern Viet Nam, although they have slightly lower yields in terms of production quantity (4%), have slightly higher production values since they are facing slightly higher output prices than in Thailand. As shown in Tables 6 and 7, only farmers from China had higher yields (230%) in terms of production quantity. Farmers in these four countries face higher input prices than farmers in Thailand. If farmers in these countries faced the same input prices as in Thailand, they would produce more, ranging from 8% more in China to 243% more in northern Viet Nam. In terms of cost, it would cost farmers in northern Viet Nam and China 71% and 3% less than the farmers in Thailand, respectively, to produce the same yield level. Estimated productivity indices based on production values showed that if farmers in these countries faced the same input prices as in Thailand, they would have higher production value, ranging from 31% higher in India to 260% higher in northern Viet Nam. In terms of cost, it would cost farmers in northern Viet Nam and India 24% and 72% less than the farmers in Thailand, respectively, to produce the same level of production value. The study of Dey *et al*. (2000) using the Philippines as a base for comparison and using dual cost indexes based on production value, revealed that farmers in China are the most productive while farmers in Thailand are the most productive in terms of production quantity, followed by farmers in China and Bangladesh for

polyculture in ponds. For tilapia monoculture both in ponds and in cages, farmers in China are more productive than farmers in the Philippines. In order for farmers in Thailand to remove the interspatial productivity differences between Bangladeshi fish farmers, farmers in Thailand must increase their yields by 12%. In the same manner, for farmers in Thailand to remove the interspatial productivity differences between Indian farmers, farmers in Thailand must increase their yields by 77%.

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[1] Estimated production was only 80 t during 1993. It substantially increased to 1 865 t in 1997.

5. DEMAND CHARACTERISTICS

Information on current and past fish consumption patterns, and how they are likely to change as production/supply, prices and incomes change, is required to assess the impact that technological change, infrastructure development and economic policies will have on food security and the distribution of fish. (Dey, 2000a). Against this background, it is necessary to examine the trends and current consumption patterns and their sensitivity to changes in production, prices and income. Such information must be species-specific or at least specific for different types of fish, as fish are not a homogeneous commodity (Westlund, 1995; Smith *et al*., 1998; Dey, 2000a). However, in most cases such information by species is not available. For this chapter the FAO database on food balance sheets was used to discuss the trends in per caput annual fish consumption and in per caput annual fish food protein intake of consumers in the selected Asian countries. Trends and changes in fish consumption by source (e.g. freshwater, pelagic, demersal, etc.) and their contribution to total fish consumption and the importance of fish food protein to total animal protein intake are also discussed. The remaining section of this chapter discusses current consumption patterns and prices of different types of fish by income class and by location (rural/urban) based on household surveys conducted by ICLARM in recent years. In examining the demand for fish in general and freshwater fish species in particular in these countries, elasticities from previous studies (Dey, 2000a; Chern, 1997; Chern and Wang, 1994; Huang and Bouis, 1996; Estrada and Bantilan, 1991; and Bhatta, 2000) were compiled and presented.

5.1 Trends in fish consumption

5.1.1 Fish food protein

Table 9 shows the trends in consumption of fish and fishery products and the contribution of fish to total animal protein. For over four decades, on average, consumers from the Philippines have had the highest daily per caput supply/intake of fish food protein in particular and animal protein in general. Daily per caput supply of fish food protein during 1997 was 11.1 g and over the last 27 years (1961-1997) it averaged at about 11.33 g. India, where almost 50% of the population are “vegetarian” and are non-fish eaters, has the lowest average daily per caput fish food protein intake (1.5 g in 1997), followed by Bangladesh and Viet Nam.

There is however a decreasing trend in daily per caput fish protein intake among Filipino consumers over the last ten years. After a record high of 13.7 g in 1990, per caput fish protein intake decreased drastically with an average annual rate of -3.36%. During the same period, fish protein intake in Thailand increased drastically from 5.9 g to 10.2 g in 1997 at an average annual rate of 5.21%. With the observed pattern, it is likely that Thailand will surpass Philippines in fish protein intake in the coming years. A drastic increase in fish protein intake is also observed among consumers in China and Viet Nam during the period 1980-97. It was estimated that average annual growth rates in these countries in the same period were 9.91% and 3.42%, respectively. While India and Indonesia have a linear growth rate from 1961-1997, a negative growth rate was observed in Bangladesh after the East Pakistan period (1973) and it was only during 1990-1997 that it began to exhibit a positive average annual growth rate of 4.85%.

5.1.2 Animal protein

The importance of fish in the diet can be estimated by the extent to which it accounts for the animal protein intake (Kent, 1997). As mentioned earlier, average per caput daily animal protein supply in the period 1961-1997 is highest in the Philippines (20.61 g) followed by Thailand (16.37 g) and lowest in Bangladesh (5.28 g). However, the share of animal protein other than fish (e.g. meat, chicken, beef, etc.) to total animal protein intake

in China was increasing during this period with an average annual growth rate of 8%. In 1997, China's daily per caput animal protein consumption was 26.2 g compared to 25.8 g in the Philippines. Thailand also exhibits the same pattern during the same period with an average annual growth rate of 3.10%. Also during the same period, animal protein supply in Bangladesh and Viet Nam started to increase from a gradually decreasing trend before 1980. These two countries have average annual growth rates of 1.63% and 3.41%, respectively. Indonesia and the Philippines have almost minimal annual growth rates, averaging 1.52% and 1.28%, respectively.

5.1.3 Share of fish food protein to total animal protein

Fish is indeed an important source of protein in these countries, as it contributes about 15-53% of the total animal protein intake. As far as the trends in share of fish protein to total animal protein are concerned, most of the countries exhibit similar patterns except for China, Indonesia and the Philippines.

Indonesia, whose share of fish protein to total animal protein is highest among the countries considered (53% in 1997 and averaging at about 59% in the period 1961 to 1997), has an almost decreasing trend throughout the period. All countries except China have an increasing share of fish protein during the period 1961 to the early 1970s, then decreasing up to 1990. While the share of fish to total animal protein increased after this (1990-1997) in most of the countries, it continues to decrease in the cases of Indonesia and the Philippines. India, which has consistently the lowest fish protein supply throughout the period 1961-1997 (and the lowest fish consumption) also consistently has the lowest share of fish protein to animal protein.

5.2 Trends in fish consumption/supply

As for fish food protein and animal protein intake, the Philippines used to have the highest annual per caput fish supply (Table 10). Average annual per caput supply during the period 1961-1998 was 31.69 kg, followed by Thailand (21.33 kg) and Viet Nam (11.21 kg). But over the last decade, average per caput annual fish consumption decreased from 37.6 kg in 1991 to 29.6 kg in 1998. Over the same period, per caput fish consumption in Thailand increased from 23.8 kg to 31.1 kg. In 1998, Thailand had the highest per caput annual fish consumption among these countries, while India had the lowest average per caput annual fish consumption (4.6 kg) followed by Bangladesh (10.4 kg), Indonesia (13.8 kg) and Viet Nam (17.1 kg).

In Bangladesh, fluctuations of annual per caput fish consumption are mainly due to fluctuations in per caput freshwater fish consumption. This indicates that freshwater fish are the main factor driving the increase and decrease in total per caput fish consumption of Bangladeshi people, and it accounts for an average of 83% of total per caput fish consumption during the period 1973-1998 and ranges from 80% to 90%. Over a longer time span, looking at the East Pakistan period (1961-1972), it was observed that per caput fish and freshwater fish consumption were increasing during this period. Then they dropped drastically to 8.3 kg and 7.1 kg, respectively in 1975 from 11 kg and 7.1 kg, respectively, in 1974. They continued to decrease steadily down to 7.4 kg and 6 kg in 1990. But with the increase in freshwater fish consumption during the period 1991-1998 (with an average annual growth rate of 4.9%), per caput fish consumption increased as well from 7.4 kg to 10.4 kg with an average annual growth rate of 4.7%. It is worth noting that, while per caput annual consumption of other fish types remained constant throughout the period, per caput annual consumption of crustacean fish increases from 0.2 kg in 1986 to 1.0 kg in 1998 with an average annual growth rate of 14.42%.

In China, the study of Hishamunda of the FAO Fisheries department, cited by the State of World Fisheries and Aquaculture (FAO, 1999b) showed that the high correlation between economic growth and fish consumption in China is an effect of the responsiveness of freshwater aquaculture to the stimulus of the market. In particular, the increase in annual per caput supply of carp and other fish species from aquaculture has meant an increase in annual consumption of aquatic products from 2.67 kg in 1952 to 7.29 in 1992, even though the population grew from 575 million to 1 172 million (Wang, 1996; Williams and Bimbao,

1998). Huang and Qiao (2000) on the other hand, reported that the successive economic reforms in the country in favour of market development, and the technological revolution that started in 1972 have substantially improved productivity and production of aqua products. Per caput fish consumption also increased subsequently. Interestingly, current FAO data shows that mollusc are also becoming an important contributor to per caput fish consumption. Per caput annual mollusc supply increased from 0.5 kg in 1980 to 6.5 kg in 1998 with an average annual growth rate of 15% compared to 4.19% during the period 1961-1998. Though consumption shares of other fish types (demersal, pelagic, other marine, crustaceans and cephalopods) are almost negligible and are decreasing, it was observed that per caput supply of these fish types were also increasing during the same period. Other marine fish in fact exhibit an annual average growth rate of 6.43% compared to 0.92% during the period 1961-1980.

India's per caput fish consumption and composition pattern is somewhat similar to that of Bangladesh. An increase in freshwater fish consumption is the only factor that influences the increase of per caput annual fish consumption from 1961 to 1998. In that period, per caput freshwater fish consumption increased with an average annual growth rate of 2.66%, resulting in an increase in per caput fish consumption from 9.5 kg in 1961 to 17.9 kg in 1998, with an average annual growth rate of 1.95%. As other fish types exhibit almost constant growth rates during the same period, shares of these fish types in total per caput annual fish consumption decreased while the share of freshwater fish increased. The increase in per caput fish consumption in India may be attributed to the increase in aquaculture production due to the intensification of the use of large ponds and reservoirs (also in China) through stocking and feeding of carp polyculture, which has supplied the domestic market especially over the past decade (Prein and Ahmed, 2000).

Indonesia's annual per caput fish consumption started to increase steadily from 9.4 kg in 1974 to 17.9 kg in 1998, with an average annual growth rate of 2.67%. During the same period, consumption of pelagic fish increased, with an average growth rate of 3.37% and surpassed consumption of freshwater fish, which decreased gradually until 1980 with a negative average annual rate of -2.39%. It was only during 1981 that freshwater fish consumption started to increase and exhibit a positive annual average rate of 2.41% up to 1998. It is worth noting that per caput consumption of demersal fish had been increasing gradually in the period 1961 to 1998, while per caput consumption of other marine fish was steadily decreasing.

As in Indonesia, the total annual per caput fish consumption in the Philippines was influenced mainly by pelagic fish, which contributed an average of 41% of the total annual per caput fish consumption during the period 1961-1998. Annual per caput fish consumption was observed to be increasing at an average annual growth rate of 3.53% during the period 1961 to 1975, with an increase in annual per caput consumption of pelagic fish. With the decline and increase in pelagic fish consumption, total fish consumption decreased and increased as well. Total annual per caput fish consumption registered a record high in 1991 (37.6 kg), then it declined drastically with an annual average growth rate of -3.45%. Consumption of all fish types decreased during this period. Per caput annual consumption of freshwater fish, which contributed an average of only 29% during the period 1961-1998, was observed to be increasing during the period 1961-1975, with an average annual growth rate of 3.44%. During the following years however, the average annual growth rate decreased at an average annual growth rate of 3.69%.

In Thailand, the average annual growth rate of per caput fish consumption of 11.25% during the period 1961-1971 can be attributed mainly to the increasing per caput consumption of other marine fish. As annual per caput marine fish consumption declined in the following years, per caput fish consumption decreased and fluctuated at around 20 kg even though per caput pelagic fish consumption was increasing. Annual per caput consumption of freshwater fish was almost constant at around 3 kg until 1988 when it started to increase with an average annual growth rate of 9.36%. During the same period, with the continuing increased in per caput pelagic fish consumption, per caput total fish consumption also increased with an average annual growth rate of 6%. Per caput consumption of demersal fish also increased during the same period with an average growth rate of 11.85%. Compared to other countries, annual per caput total fish

consumption in Thailand is well distributed, with pelagic fish accounting for 29% on average of the total per caput fish consumption, followed by freshwater fish (18%), pelagic other marine fish (16%) and crustacean (11%).

In Viet Nam, annual per caput consumption of other marine fish, which contributed an average of 59% of the total per caput fish consumption during the period 1961-1998, is the main factor that influenced total annual per caput fish consumption. As in Thailand, annual per caput fish consumption of freshwater fish is almost constant at around 3 kg, accounting for 27% of the total per caput fish consumption (the average annual growth rate during that period was 0.07%). Freshwater fish consumption started to increase from 2.9 kg in 1992 to 5.7 kg in 1998, with an average annual growth rate of 12%. During the same period, annual per caput consumption of marine fish and total annual per caput fish consumption increased drastically with an average annual growth rate of 5.3% each, compared to a declining average annual rate of -2.97% and -1.43%, respectively, during the period 1961-1991. It is worth noting that annual per caput consumption of crustaceans also increased during the period 1985-1998 with an average annual growth rate of 9.36%. Per caput annual consumption and share of other fish types remained constant and insignificant.

5.3 Prices of different fish species

As stated earlier, demand for fish is influenced mainly by price and consumers' incomes. Price is an essential factor in the consumers' choice of the species that is within their reach. To understand better the demand for fish by species or source (capture or culture, marine or freshwater), one needs to examine the prices of different fish species in each country.

In general, prices of freshwater fish species are lower as compared to fish species from other environments/sources (Table 11). Among the different freshwater fish species in Bangladesh, silver barb seem to be the cheapest, followed by silver carp and assorted small fish. Among the Indian major carps, rohu is the most expensive, while mrigal is the cheapest. Although tilapia is one of the cheapest fish in the Philippines, its price is very much higher compared to other countries. In fact, the market price of tilapia in the Philippines is higher than the price on the international market, making it difficult for the Philippines to compete in the export of tilapia (Dey and Eknath, 1997).

Historically, brackish water fish have higher farm-gate prices than those from freshwater aquaculture. In spite of the increasing trend of production, prices are also generally increasing in most of these countries - particularly in Bangladesh. The price of rohu (a dominant Indian carp species) increased by 3.71% (wholesale) and 1.88% (retail) during the period 1985/86-1995/96, although production increased significantly during the period (Alam, 2000). In the Philippines, from 1988 to 1998, consumer price indices in the urban area (the National Capital Region or NCR), outside of NCR and for the country as a whole, have increased and purchasing power has been reduced by 10.62%, 8.94% and 9.42%, respectively (Olalo, 2000). Farm gate prices of milkfish, prawn and tilapia have registered positive growth rates, while carp species have registered negative. In Thailand, prices of cultured species are decreasing in general as compared to captured species (Piumsobun, 2000). As more and more farmers adopt the GIFT (Genetically Improved Farm Tilapia), prices of tilapia will decrease in these countries (Dey, 2000b).

5.4 Fish consumption preferences

The DEGITA and carp consumers' field surveys (ICLARM, 1998 and 2000) showed that annual per caput fish consumption rates are 19.92 kg in Bangladesh, 31.08 kg in China, 15 kg in India, 15.81 kg in Indonesia, 46.0 kg in the Philippines, 28.80 kg in Thailand and 12.86 kg and 37.80 kg in northern and southern Viet Nam, respectively (Table 12). FAO data however showed that the average national annual per caput fish consumption rate during 1998 was highest in Thailand (31.10 kg), followed by the Philippines (29.0 kg), China (25.70 kg), Indonesia (17.9 kg), Viet Nam (17.1 kg), Bangladesh (10.40 kg), and India (4.6 kg) in 1998 (FAO, 2000b). Except for Indonesia and Thailand, figures from the field survey are considerably higher than what is reported in the national average. Lower figures for the country average may be mainly due to the fact that sampled areas are

located in fish-producing areas, where per caput fish consumption is higher than in non-fish-producing areas.

The carp consumer field survey (ICLARM, 2000) showed that silver carp is in top position of the fish consumption basket in Bangladesh. Basically, Indian major carps such as rohu, catla, and mrigal are the preferred species in Bangladesh by all yardsticks. It may be that field demonstrations of different projects and NGOs over the past couple of years have convinced farmers that silver carp grows faster. The silver carp therefore, dominates the stocking in these areas. People consume the species as it is available and at an affordable price. Chinese consumers have indicated that grass carp, silver carp, crucian carp and common carp are the favoured species. In India, rohu and catla are the common and preferred species. In the Philippines, tilapia is the preferred freshwater species. Among marine/brackish species, milkfish is preferred. In general, marine fish species are preferred among consumers in the Philippines. Consumers in landlocked areas of Thailand on the other hand, are very fond of tilapia, silver barb, snakehead and catfish. In these areas, marine fish constitutes only about 8% of the total fish consumed. In northern Viet Nam, rohu, grass carp, silver carp, silver carp, tilapia and common carp are the preferred fish species. On the other hand, marine fish are preferred in southern Viet Nam. Among freshwater fish species, snakehead is preferred in southern Viet Nam.

To see the importance of freshwater fish species in the consumer's budget, Table 13 shows the proportion of each species in total fish expenditure. In Bangladesh, assorted small fish, rohu river shad and catla, which are all freshwater fish, dominate fish expenditure among Bangladeshi consumers regardless of income class. As expected, on average, lower income group consumers buy cheaper species such as silver carp, silver barb, tilapia and river shad, while higher income groups consume relatively expensive species like catla, exotic carp and live species. In China, crucian and grass carp are the two most important species bought by all income groups, but higher income groups spend more on other/marine fish (others) than lower income groups. This is also true in India, the Philippines and Thailand. Indian carps (rohu and catla) are the freshwater species preferred by consumers in India. In Thailand, snakehead, tilapia, silver barb and marine fish are the species on which most consumers spend their money. Marine fish accounts for 15% on average of total fish expenditure. Lower income groups spend more on tilapia and silver barb on average compared to higher income groups. In northern Viet Nam, rohu, tilapia and common carp are the preferred species among the upper and medium income groups, while rohu and silver carp are preferred by the lower income group. Unlike in Thailand, in northern Viet Nam the higher income group spends more on average on tilapia than the lower income groups. In southern Viet Nam, consumers spend more on snakehead. On average, marine fish accounts for 11% of total fish expenditure.

Lower income groups tend to spend more on food items (60-80% of total expenditure) compared to higher income groups (35-50%) (Table 14). However, the contribution of fish expenditure to total expenditure (food and non-food) is higher among lower income groups. This is also true for the contribution of fish expenditure to total food expenditure, except in China and Viet Nam. Although per caput fish consumption is higher among higher income groups, contribution of fish expenditure to total animal protein expenditure is higher among lower income groups. This shows that fish is an important source of protein among relatively poorer households in these countries. No wonder it is regarded as “poor man's protein” (Williams, 1996).

The consumers' survey also indicates that annual per caput fish consumption in rural areas is substantially higher than in urban areas (Table 15). Producer-consumers have the highest fish consumption, followed by rural-consumer and urban-consumers.

5.5 Consumer preferences for various freshwater fish

Price and income influence consumer demand and preferences. However, price is just one of many factors that determine preference. There are more fish-specific characteristics or traits that consumers consider when choosing fish. In the light of government efforts and the support of different funding and research institutions to come up with genetically

improved species, it is essential to examine the preference patterns of consumers for different fish and fish traits.

Table 16 presents consumers' preferences for freshwater species based on the results of the carp consumer survey. The table shows that the species preferred by consumers in Bangladesh and India is rohu, followed by catla and mrigal. Common carp is preferred by consumers in Indonesia and southern Viet Nam, followed in the latter by snakehead and silver carp. Consumers in northern Viet Nam rank grass carp as the preferred species, followed by mud carp and common carp. Chinese consumers choose crucian carp first, followed by grass carp and common carp. In Thailand, the preferred freshwater fish is tilapia, followed by snakehead and catfish, while silver barb ranked fifth. The reasons for consumer preferences for these species are mainly good taste, reasonable price and easy availability (ICLARM, 2000). Good physical attributes are the reason for high preference of silver barb among Bangladeshi consumers.

The sample respondents were asked to rank the traits they prefer for individual species. The results of the exercise are presented in Table 17. Interestingly, the table shows that trait preference varies considerably among the three most preferred species within a country, except for rohu and catla in Bangladesh, where colour and higher dress-out percentage rank first and second, respectively for these two Indian major carp. Also, for the same species, preferred traits vary considerably among countries except for mrigal, for which higher dress-out percentage is the preferred trait among Bangladeshi and Indian consumers. Another exception is common carp, where its better flavour is preferred by Chinese and northern Vietnamese consumers, and also grass carp where its bigger size is preferred in both countries. Unlike Bangladeshi consumers, Indian consumers consider the body shape and flavour of rohu and bigger size and higher fat of catla as more important than their colour and higher dress-out percentage. As in India, body shape, size and flavour are among the traits that are preferred by Chinese consumers for their preferred species. Crucian carp is preferred because of its body shape and grass carp because of its bigger size.

Higher dress-out, bigger size, better flavour and body shape are the traits considered important by Thai consumers for silver barb. Vietnamese consumers from the south on the other hand, preferred the higher fat content of the same species. Higher fat is also the most important trait for common carp for the Vietnamese from the south. While the same consumers considered the colour of silver carp as most important, consumers from the north named its higher fat content.

Table 18 shows consumers' preferences for size, shape, colour and other parts of the fish. All carp species except silver barb are preferred in bigger size, up to 3 pcs/kg^{-1}. Surprisingly, consumers in Bangladesh seemed to prefer bigger size (<1 to 1 pc per kg) compared to other countries. Southern Viet Nam and Thailand on the other hand prefer smaller fish (<2 to 3 pcs per kg).

Shape preference for carp species such as rohu, mrigal and grass carp varies across countries. Consumers in Thailand and India prefer long and thin shape for rohu and mrigal, but those in northern and southern Viet Nam prefer short and thick shape. For grass carp, consumers in China and India prefer long and thin shape, whereas those in northern and southern Viet Nam like short and thick. For common carp, silver carp, silver barb catla and crucian carp, consumers in all countries preferred short and thick and short and deep.

Another interesting finding is that colour preference for the same species also varies across countries. Rohu is preferred in silver (Thailand), light (northern Viet Nam) and bright (southern Viet Nam). Common carp is preferred mostly in yellow, with additional reddish colour for Chinese consumers. Mrigal is preferred in silver (Thailand), black-blue (northern Viet Nam) and bright (southern Viet Nam). Silver carp is mostly preferred in silver (China and northern Viet Nam) and bright colour (southern Viet Nam). For silver barb, silver (Thailand), light-blue (northern Viet Nam) and yellow fin colour (southern Viet Nam) are preferred. Grass carp is preferred in black/green/silver in China, whereas light and bright colours are preferred in northern and southern Viet Nam, respectively.

Like colour preference, consumers' preferences for different parts of fish vary significantly across countries. Table 18 shows the three most preferred body parts of the preferred species in each country. Consumers in Bangladesh mostly prefer the belly, tail and back portion of rohu and mrigal, while the head portion is most preferred for catla. Indian consumers on the other hand, prefer the back portion to the belly of rohu, while the egg is preferred to the tail of mrigal. In Thailand, the back portion is preferred for all species. Interestingly, consumers in northern and southern Viet Nam do not only differ in species preference, but also in preference for body parts of the same species. This suggests that the species and traits for genetic improvement should be different in these two areas.

5.6 Expenditure and demand elasticities for fish

Estimates on elasticity of demand for fish in Asia are very scanty due to scarcity of data. To date, the most promising work on the estimation of fish demand at an aggregate level in these countries is the work of Dey (2000a) on Bangladesh. Table 19 presents available information on demand elasticities for fish in these countries. Alam (2000) estimated expenditure and income elasticities for demand for fish in Bangladesh to be 0.79 and 0.65, respectively. These indicate that demand of fish increases with the increase of expenditure and income, respectively. But the increase in demand for fish is more sensitive to the increase in expenditure than in income. The estimates of Dey (2000a) on fish expenditure with respect to food expenditure vary from 2.67 for the poorest quartile group to 0.89 for the richest quartile. Dey's estimates for fish expenditure elasticity with respect to income vary from 1.52 for the poorest quartile to 0.62 for the richest quartile. These results show that expenditure and income elasticity for demand for fish fall with an increase in expenditure and/or income, suggesting that fish is a luxury commodity for the poor and a necessity for the rich. Compensated own-price elasticities for various types of fish (aggregate level) among quartile vary (absolute value) from -0.42 (poorest) to -0.59 (richest) for assorted small fish to -2.02 (richest) to -2.87 (poorest). This indicates that prices of carps are more elastic than any other fish types, while prices of assorted small fish are inelastic. It is worth noting that for carps, low-income groups are more sensitive to price changes than high-income groups, while the reverse is true for assorted small fish.

Alam (2000) estimated the own-price elasticities of demand for fish by species in Bangladesh. Provisional estimates are: -1.13 for rohu carp, -0.75 for catla carp, -0.91 each for mrigal and silver carp -1.07 for other exotic carp, -1.09 for silver barb, -0.91 for river shad. This is -1.10 for assorted species, -0.98 for live species and -0.93 for high valued species.

China has various estimates for elasticities of demand. Expenditure elasticities of demand for aquatic products in general are 1.45 for the country as a whole and 1.39 and 1.48 for rural and urban areas, respectively. Expenditure elasticity estimates derived from quadratic expenditure system range between 1.86 to 2.85. Ye (1996) estimates using a panel data (1978-91) showed that income elasticity of aquatic product is 1.93. In any case, one can conclude that fish consumption in China, just like in other countries is sensitive to income changes. Ye (1996) also concluded that the responsiveness of demand to income is stronger than price. The own-price elasticities of demand for fish were -1.48 (estimated from LA/AIDS model) and -1.78 to -2.37 (derived using quadratic expenditure system) which show that demand for fish in China is very elastic and sensitive to price changes.

In India, to the best of our knowledge there is no study that estimates elasticity of demand for a particular species of fish, or for fish as a separate group. The only available information is an aggregate figure comprising fish, eggs and meat. Different expenditure elasticity estimates range from a minimum of 0.63 to a maximum of 1.04 (Bahalla and Hazel, 1998). Estimates also show that the urban expenditure elasticities of demand for fish, meat and eggs are higher as compared to rural areas in India. Meenakshi and Ray (1999) estimated the meat-egg-fish elasticities to be -1.965 for rural areas and -0.913 for urban areas in India.

In the Philippines, own-price elasticities of demand are -0.65 for tilapia, -0.63 for milkfish, -1.50 for tuna, -0.41 for round scad and -1.52 for prawn (Olalo, 2000). Dey's (2000) estimates are -1.00 for tilapia, -1.2 for carps, -1.50 for crustaceans, -1.5 for other high

value fish and -0.75 for other low valued species. Income elasticities of demand for fish in the Philippines tend to go up as income goes down, and this holds for both rural and urban areas.

Own price elasticity for freshwater cultured species in Thailand is -1.2, cross-price elasticity with respect to chicken price is 1.3 (Piumsonbun, 2000). These results show that freshwater fish and chicken are complementary commodities in Thailand. The income elasticity of demand for fish is 0.8. Magnitudes of price and cross-price elasticities of demand are different for different species. Both the own-price elasticity of demand for Nile tilapia and cross-price elasticity of demand for Nile tilapia with respect to striped catfish are -0.70. This means that striped catfish is a substitute for tilapia. Income elasticity of demand for Nile tilapia is however, very high (4.1). For silver barb the elasticities are -0.7 (own-price), 0.3 (cross-price with respect to striped catfish) and 2.2 (income elasticity). For walking catfish, the magnitudes are -0.9 (own-price), 1.1 (cross-price with respect to chicken price) and 2.5 (income elasticity). Price elasticity of demand for striped snakehead is 0.9, while the cross-price elasticity of the same with respect to beef, pork and chicken prices are 4.6, 2.4 and 1.1 respectively. Dey (2000a) estimated elasticities of demand to be -1.0 for tilapia, -1.10 for carps, -1.50 for crustaceans, -1.50 for other high valued species, and -0.50 for other low valued species. Income elasticity of demand for snakehead fish is 2.2.

5.7 Discussions on fish consumption and demand

FAO data show that fish has become an increasingly important source of protein over the last decade in most of these countries. The exceptions are Indonesia and the Philippines, where the supply of fish food protein is being replaced by other sources of animal protein, resulting in a decrease in the share of supply/consumption of fish food protein to total supply/consumption of animal protein. In the Philippines, even though the supply of fish food protein has been decreasing over the past decade, total supply in animal protein is still increasing. This implies that consumers in the Philippines do not depend on fish as a source of protein. In the case of Indonesia, both supply of fish food protein and total supply of animal protein is increasing, but the rate of increase in total supply of animal protein is higher than the increase in supply of fish food protein, resulting in the decrease of the share of supply of fish food protein to total supply of animal protein.

In Bangladesh, the per caput supply of fish food protein is the factor driving increases and decreases in the per caput supply of total animal protein. This indicates that fish has not been replaced by any other forms of animal protein (Prein and Ahmed, 2000; Kent, 1997) and that Bangladeshi people are very dependent on fish as a source of animal protein. In Viet Nam, it was not until the last decade that fish food protein became an important source of animal protein.

Results show that demand for fish increases as expenditure/income increases and that higher income groups tend to consume more fish than lower income groups. However, the share of fish (as protein) and share of fish to total food expenditure are higher among lower income groups, suggesting that lower income groups are the most dependent on fish. This result is also consistent with the generalization that although less developed countries are not the biggest consumers of fish, they are the most dependent on it (FAO, 1993; UNDP, 1993; Kent, 1997; FAO, 1999b).

With so many poor people highly dependent on fish, it is a matter of serious concern when their caput supply decreases over time. Though production is increasing, the continuing growth of population and the growth in disposable incomes means that production is not likely to keep up with demand (FAO, 1993a; Williams, 1996). So long as demand outruns supply, prices will go up and this affects the lower income groups most. Kent (1998) reported that this is already evident in nations such as India and the Philippines, where middle class people feel they can no longer afford to eat fish as part of their regular diets.

There is also cause for concern about the impacts of international trade on fish supplies for consumption in these countries. Fisheries trade can lead to declining food security, especially in those countries that eat more marine (pelagic and demersal) fish, such as

Indonesia, the Philippines, Thailand and Viet Nam, since a large share of the exportable fishery products are coming from these sources. As international trade in fishery products grows rapidly, species once commonly eaten throughout the country are now exported.

In Bangladesh where freshwater fish accounts for an average of 83% of the total fish protein, international trade in fishery products does little harm to fish food supplies as reported by Kurien (1993). This is due to the fact that most of the freshwater fish species are not exportable and are only used for domestic consumption. Dey and Bimbao (1998) reported that shrimp accounted for about 91% of the total fishery exports in Bangladesh, which comprised about 69% of the total shrimp production in the country.

With its strongly increasing production, relatively lower price and relatively limited international market, freshwater fish is expected to become an increasingly important as a type of fish and as a source of animal protein, particularly for those in medium and lower income group of these countries.

6. FISH MARKETING PRACTICES

6.1 Marketing intermediaries and channels

Fish marketing in Bangladesh, India, Thailand and the Philippines is largely controlled by the private sector. Three to four intermediaries operate between producer and final consumer (Table 20).

In Bangladesh, the dominant marketing channel (product route to ultimate consumers) of freshwater fish for domestic consumption includes farmer-*bepary-aratdar-paiker*[2]/retailer-consumer (Fig 1). This simple channel covers primary and secondary market levels up to Upazila. Beparies handle a large volume of fish and sell their purchases to Aratdars and to Paikers/retailers. Beparies do not generally hold any trade licences, unlike Aratdars[3]. They can be local or non-local traders. Some Beparies get advance business loans from the Aratdars during lean periods and on the condition that they will sell their purchases through Aratdars. From the higher secondary markets, fish flow-down again to the town and peripheral village primary markets (final consuming markets) through Paikers/retailers. Fig 2 shows the flow of the quantity of fish being channelled to different intermediaries.

Coulter and Disney (1987) observed that “communication between the traders in different markets is generally good and takes place by telephone [nowadays cellular phones are also used] and this keeps wholesale prices in line throughout the country. The least informed party is the fisherman, because of his physical isolation from the markets. Other factors which weaken the fisherman's bargaining position are his dependence on credit and illiteracy”.

With the growth in commercial pond fishery, a new pattern is emerging in the marketing channel (Alam, 2000) that affects production points, primary markets/landing areas, higher secondary markets and consuming areas/retail markets. The flow of harvest between intermediaries is shown in Figure 3. As shown in the figure, after harvest pond fish farmers directly approach Aratdars at the higher secondary market. Fish farmers get 8-10% of the total sale proceeds from the lot of each catch. The farmers bear the transportation costs to the Aratdars in the markets and arrange bidding for open sales of fish to paikers/retailers. In lieu of providing space for fish landing, icing for some fish and selling, Aratdars get commission at different rates of the sale proceeds. For example, commission for Hilsa fish is 3%, for carps 4%, rohu, catla mrigal 6.20% in Mymensingh and Kishoregonj markets.

The limited number of wholesalers, their joint actions in bidding and close understanding through their associations negate the principles of competitive market structure. Inadequate competition at the Aratdar level mean that the Beparies pay relatively higher commission, and the effect of this is born ultimately by the fish farmers/fishermen, who get lower prices. Open auctioning of fish lots by the wholesalers to Paikers/retailers makes the market structure competitive at retailer level in the final consuming markets. Therefore the market structure situation is not the same for all market levels. Exploitation prevails from the farm-gate to the higher secondary market level.

China's marketing channel for freshwater aquaculture products in general is a bit different to that of Bangladesh. According to the origin of aqua-production (marine culture and freshwater culture), the products enter the coastal and inland producers' markets. From there, the products enter state, collective or private markets and processors. A portion is delivered to producers operating at this market level. It then reaches the consumers' market. It is acknowledged that the liberalization of the aquatic products market has resulted in a prosperous aquatic market, which means that the share of the state-run marketing channel is decreasing rapidly while the total number of transactions is increasing dramatically.

India is a country of several states with different languages, traditions and castes. A significant proportion of the Indian population does not eat animal protein including fish. Therefore, fish produced by one state is moved to other states. As for Andhra Pradesh, it exports its aquatic products to West Bengal. Bigger fish weighing 2 kg or more have high demand in West Bengal markets. The smaller sized fish are sold in local markets. In the local markets, cycle vendors and small merchants buy small quantity of fish at pond bunds from small farmers and sell to the domestic consumers. The middlemen finalize the deal by negotiating with both producer and wholesaler, for which they receive commission from both parties. Middlemen takes a commission of US$ 10.87 from both the producer and the wholesaler for every truckload (5 t) of fish, which is about 5% of the total sale value of the fish.

In the Philippines, fish marketing is generally characterized by shorter distribution channels than those for agriculture products. In general, there are four types of middlemen/fish traders engaged in fish marketing in the country, namely: the brokers, wholesalers, wholesaler-retailers and retailers.

Fish traders buy and sell all kinds of fish - freshwater, brackish water and marine. A majority or 70% of the traders directly obtain their supply from fish producers, while the rest (30%) buy from wholesalers (Olalo, 2000). This shows that traders are exploring the possibilities of increasing profit by dealing directly with fish producers. Specifically for tilapia, this confirms the earlier finding that the marketing channels through which tilapia passes are very short: from producers to wholesalers then to retailers and finally to consumers (Torres and Navera, 1985). Also, between 5% and 19% of the fish farmers were able to sell their fish to restaurants. As in most of these countries, small pond tilapia operators usually kept some of their produce for home consumption, while medium and large pond owners sold 100% of their harvest. The percentage of farmers keeping tilapia for home consumption decreased as pond area increased indicating that increased pond area was associated with increased entry into the cash market economy (Molnar *et al*., 1996). Milkfish pond operators are also generally market-oriented. As much as 98-99% of their total produce is sold and only 1-2% is for home consumption. Large milkfish pond operators usually sell their produce directly to wholesalers, either by consignment or contract selling. Only small pond operators are engaged in direct retailing. This is also true for tilapia farmers.

Fish traders obtain their fish supply 4 - 55 km away from the trading market (Regaspi *et al*., 1997). As expected, they source their fish supply as near as possible to the market as this has implications for their transport and marketing costs and ultimately for their profit. As the distance and travel time are relatively short, this also provides the opportunity for fish producers to sell their fish directly to the market as a way of increasing their farm income. A majority, or 55% of fish traders used jeepneys to transport the fish from the source to market, as this is the most accessible mode of transport in the Philippines.

Domestic freshwater fish marketing in Thailand is complex as it involves many types of markets and a larger number of intermediaries and participants. The flow of freshwater fish marketing with distribution of product volume traded at different levels of traders is shown in Figure 4. As shown in the figure, the market structure of cultured freshwater products is classified into three major market levels: primary markets, intermediate markets and terminal markets. Fish farmers distribute their harvest to every level but the highest proportion (35%) is sold to primary markets through fish collectors. Most small-scale fish farmers rely on fish collectors who have experience and more information about fish market outlets. Also, it may not be worthwhile for fish farmers to transport small volumes of fish.

After buying fish at fish farms, collectors will transport and sell the product in the central assembly markets, which are either state-owned or private. State assembly markets are managed by the Fish Marketing Organization (FMO[4]), where fish are sold through registered fish agents. Private assembly markets on the other hand, are run by private persons where fish traders are non-registered fish agents. Fish collectors collecting fish from the primary markets are involved directly in selling. As stated earlier, fish farmers can bring their produce directly to these markets and sell directly without resorting to help from

any intermediaries. However, in some markets, both fish farmers and agents collect fish from the primary markets. Fish brought to these markets by farmers are sold through fish agents, for which the farmers pay a commission[5].

Fish agents, both FMO and private, as well as fish collectors in the assembly markets distribute most fish to wholesalers (44% of total fish volume), then to retailers (16%) and fish processors/cold storage (14%). Wholesalers distribute most of the fish directly to retailers (about 55% of total fish volume), while 4% is sold to processors/cold storage and 1% is exported. Fish exported by wholesalers to nearby neighbouring countries (like Burma) are mostly catfish (*Pangasius sutchi*).

Processors/cold storage have another route of processed fish distribution: 13% of total fish production is distributed to wholesalers; 6% is sold directly to retailers[6] and another 6% is exported. Most of fish exported are chilled and frozen. The volume of many species that are exported fluctuated during the past years. Walking catfish and snakehead are exported to the United States of America, Japan and Europe. Thai silver barb, tilapia, rohu, and mrigala and other similar freshwater fish are mostly exported to the Near East while catfish (*Pangasius*) is exported mostly to Europe and Asia.

Retailers are the last channel before the fish reach the consumer. From the marketing channel and percentage of freshwater fish distribution, it can be deduced that 93.4% of total cultured freshwater fish is consumed domestically, of which 74.3% is bought fresh/alive and 19.1% is bought in several processed forms. Exports account for 7% of total freshwater fish production, mostly in chilled/frozen form.

As far as marketing channels in rural areas are concerned, small-scale wholesalers and retailers buy the fish directly at the fish farms nearby. Species of fish traded in rural areas are low-priced species of small size that consumers are able to afford.

6.2 Marketing margins and the producer's share

In Bangladesh, marketing margins vary for different intermediaries, ranging from US$ 6.29 to US$ 14.18 per quintal of fish marketed (Table 20). The farmers' (or producers') share in the consumers' price is about 56% (Alam, 2000). Marketing margins vary according to the seasons in India. They range from 50 to 60%. In Thailand, margins vary for different fish species. The margin for Tilapia is 41.1% implying that 59.9% is the producer's share in the consumer's price. For silver barb, walking catfish and striped catfish, the producer's share in the price to the consumer is 51.4%, indicating that 48.8% is the marketing margin. The producers' shares in the price the consumers pay for fish are highest for striped snakehead (75%) and salted and dried sepat Siam (76%).

Traders in Philippine fish markets realize a price margin of US$ 0.10 - 0.40 per kg of fish marketed. By species, traders obtain a price margin of US$ 0.20 (tilapia, milkfish), US$ 0.10 (catfish), US$ 0.30 (bisugo), US$ 0.40 (crustaceans), US$ 0.20 (other marine fish), and US$ 0.15 (other freshwater fish) by marketing 1 kg of fish. With these price margins, fish trading appears lucrative.

6.3 Marketing barriers/constraints and physical facilities

Table 21 shows the major constraints faced by the fish farmers in the region. At the primary market level, the main constraint for Bangladeshi and Indian fish farmers are lack of bargaining power and market information and barriers to entry in the market. Lack of transport is another important constraint preventing producers from sending produce to higher markets. Thus they often end up being paid lower prices by the existing buyers, as the product cannot be kept for long periods because icing facilities are absent in almost all primary markets. Physical facilities and infrastructure in all types of market are far from satisfactory. Most primary/village markets do not have facilities for electricity, water, ice, or shelter. Fish sellers in the majority of rural and primary markets sit under the open sky. Secondary and higher level markets have better facilities, though in general, conditions in urban and retail markets are far from satisfactory with regard to stalls, parking, spacing, sanitation, drainage and management.

Apparently, access to Thai fish markets is less constrained. However, sellers and fish producers do face serious problems, such as: supply scarcity, lack of buyers, bad debt, lack of market information, non-availability of regular retail markets, rising marketing costs and inadequate transportation (Piumsombin, 2000). In general, market infrastructures and facilities in Thai and Filipino fish markets are better than those in Bangladesh and India.

6.4 Credit facilities

Credit can be obtained from public sector institutions (such as banks) and from the private sector (non-institutional). In Bangladesh, the credit situation of the public sector for pond fish farmers is very poor. It was reported that only 20% of fish farmers in the country obtained institutional credit (Shang, 1990). Alam (2000) on the other hand, reported that about 16% of pond farmers could obtain credit from either public or private sources. Most farming operations are run using farmers' own capital. Creditors from the public sector are mostly large-scale farmers. Rahman and Ali (1986) also reported that access to institutional credit by the fish farmers is very low. In addition, Alam and Bashar (1996) reported that intermediaries provide production credit linked with marketing, where the aqua producers receiving credit are obliged to sell their produce to the credit supplier for slightly less than the market price. By any measure, access to credit is very limited for the overwhelming majority of pond-fish farmers. Also, there are no insurance schemes to cover the loss of fish production.

In India, most of the credit flows are also from the private non-institutional sector. Merchants provide finance for fishing operations in inland capture. Apart from the marketing agents, professional moneylenders advance credit against securities of gold and agricultural properties. Problems like multiplicity of pond ownership, non-recognition of aquaculture as a land-based activity, the absence of long-term leasing policy and non-assurance of seed supplies at the appropriate time constrained access to credit.

In the Philippines, the bulk of credit extended for fish marketing and processing is provided by marketing intermediaries in the form of short-term working capital advances to suppliers and small-scale fish processors. Only during the last few years have financial institutions been involved in financing domestic fish retail marketing and small-scale fish processing in the context of rural development and anti-poverty programmes. Credit for capital investments in fish marketing and processing for the establishment, upgrading or purchasing of processing and storage plants and transport facilities is more often provided by the financial institutions than by the informal sector.

The Government of Thailand does not have any special credit programmes for fish producers and marketers owing to the fact that trading is left in the hands of the private sector. Fish trading agents, for the sake of their businesses, provide interest-free credit to producers and fish suppliers. Large-scale processors/cold storage owners and big company-oriented fish agents have good access to the existing institutional credit facilities of the country. There is no insurance scheme that covers the production and marketing risks of aquaculture products.

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[2] Paiker - a small-scale wholesaler who may perform retailing at the same time.
[3] Trade licence fee of Aratdars is about US$ 6.12/year. In a survey of Alam (2000) in Mymensigh, he estimated that the monthly income of Aratdars during peak period (Oct-Jan) ranges from US$ 612-714.
[4] FMO is a state enterprise under the Ministry of Agriculture and Cooperatives.
[5] At FMO assembly market, according to the Royal Decree of fish agents, the commission fee charged by the fish agents must not exceed six percent of gross sale value.
[6] Wholesalers and retailers of processed fish are different groups from those sell fresh fish.

7. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

The Asian countries selected for the present study have similarities as well as dissimilarities as far as fisheries and fish farming are concerned. Fisheries are a priority area in all the countries. Broad macro-policies for aquaculture or for fisheries are largely the same, although the strategies for achieving targeted objectives are different. All countries have the common objectives of increasing fish production, improving export earnings, providing more animal protein and expanding employment opportunities in the fisheries sector.

In general, while agriculture's contribution to the GDP is declining in all the countries, the contribution of fisheries is increasing except for in Thailand. In particular, while freshwater fish production has been increasing in these countries, the contribution from India, Indonesia, the Philippines and Thailand to total world freshwater production is gradually decreasing. Freshwater fish from inland water in Bangladesh contributes most of the fish produced in the country. In China, cultured fish now dominates aquatic production.

Of the different aquaculture production systems, freshwater ponds are by far the largest contributors to fish production in these countries - supplying low-priced food fish for household consumption. In the Philippines, cage culture is as popular as the pond.

Farm/pond sizes are quite high for China (averaging 2.3 ha for individual household farms and 43 ha for state-owned farms) and for the Philippines (3.53 ha), while they are much smaller in Bangladesh (0.22 to 0.30 ha), India (about 1 ha) and Thailand (0.49 ha). Water bodies for aquaculture are largely owner-operated in Bangladesh, India, Thailand and the Philippines, unlike in China. While polyculture is a general practice in all the countries, monoculture is widely practised in China and the Philippines for cage culture and in Thailand for culture of carnivorous species such as walking catfish. Integration of animals with fish is also common in China, Thailand and Viet Nam. Rice-fish farming is also practised in these last two countries as well as in Indonesia and to some extent in the Philippines. Culture of fish (common carps) in running water systems is unique to Indonesia.

As regards species, Bangladesh and India have major (Indian) carp (rohu, catla and mrigal) and silver carp as the dominant species. A good deal of similarity exists between Thailand and the Philippines in terms of tilapia. While milkfish and seaweeds are dominant in the Philippines, walking catfish and Thai silver barb are some other dominant species in Thailand. China is different from the rest of the countries in many respects namely, species composition, culture intensity, productivity and marketing. Chinese carps such as silver carp, big head, grass carp, and crucian carp are the most important in this country. Fish farmers in Viet Nam on the other hand, culture both Indian major carps (rohu) and Chinese carps (common carp, silver carp and silver barb). Interestingly, while silver rohu and silver carps are the dominant cultured species in northern Viet Nam, common carp and silver barb are the dominant species in the southern part of the country.

High stocking density and low use of supplementary feed and fertilizer are characteristic features of the aquaculture practices of Bangladesh and India in general, and to some extent of Thailand and the Philippines. Although feed and fertilizer use is high for countries such as China, Indonesia, Thailand and Philippines, nevertheless a good number of the fish farmers use low inputs in these last three countries. Cultured ponds in Bangladesh, India and Viet Nam make use of relatively lower inputs and thus the operations can be regarded as semi-intensive or improved extensive. Freshwater farms are more of a subsistence nature in Bangladesh and Viet Nam, where aquaculture has developed mainly as a rural activity integrated into existing farming systems. On the other hand, in China,

India, Indonesia, Thailand, and Philippines aquaculture is largely a commercial activity. China in particular uses high stocking density and feed fertilizers and does not have any practice of extensive farming. Cage culture has the most intensive application of inputs and stocking.

Yields, costs and returns vary considerably among countries. This can be attributed to the variation in intensity levels, production environments and systems and culture practices. On average, China showed significantly higher yields and profits, while India showed lower yields and profits. Cage culture in Indonesia produced significantly higher yields than running water systems. Rates of return and break-even prices are lowest in Bangladesh and Thailand, which suggests that farmers from these countries are more cost-effective. After accounting for the differences in input prices, interspatial TFP computation showed that farmers in northern Viet Nam are more productive among the pond operators, based on quantity and value of production. This finding contradicts an earlier study conducted using dual cost indices based on production value, which showed Thailand as the most productive in terms of production quantity, followed by China and Bangladesh. For tilapia monoculture both in ponds and cages, China is more productive than the Philippines.

Feed costs account for most of the variable costs for pond operation in China and Thailand and in Indonesia's running water and cage systems. For all countries except India, the cost share of fingerlings to total cost ranked after feed cost.

Women's participation is high in general in production activities in Bangladeshi aquaculture, and low in marketing, although it is high in marketing activities for all other countries. In general, involvement of womenfolk in the fields of fish production, processing and marketing has been on the increase in all the countries, although their participation is highest in fish marketing.

Over the last decade fish has become an increasingly important source of protein in most of these countries, except in the Philippines where fish food protein is being replaced by other animal food protein sources. The annual rate of per caput fish consumption is likewise increasing in most of these countries except in the Philippines, which used to be the leader in per caput annual fish consumption. In most of these countries, especially Bangladesh, freshwater fish contribute significantly to the total per caput fish consumption. On the other hand, the ever-expanding export market for aquatic products, specially those from marine sources, combined with rapid population growth, have led to reduction in supplies for local markets, one of the reasons for the declining fish consumption in the Philippines.

Fish consumption preferences vary across countries. A few common characteristics in all the selected countries include: (a) people of higher income groups consume more fish than those of the lower income groups, though the proportion of the food budget allocated to fish expenditure is higher among low income groups; (b) rural people consume more than urban dwellers; (c) fish producers in general consume more fish than non-producers; and (d) demand for fish is very sensitive to price changes. Religious beliefs and ethnic and geographical differences also explain variations in fish consumption across countries. For instance, vegetarians in India avoid fish in their diet. Coastal communities have strong preferences for marine species.

Freshwater aquaculture has had a positive impact both in terms of production and prices. In general, freshwater fish, which is cheaper, is an indispensable source of animal protein, as it is preferred among the lower income groups in this these countries. However, in spite of the production increase for freshwater fish in particular and total fish supply in general in the past decades, prices of aquatic products have increased in all the countries.

Marketing is organized almost entirely by the private sector, although some degree of government intervention exists in China and the Philippines. Market structure, conduct and performance are poor in Bangladesh and India, but moderate in Thailand, China and the Philippines. Markets are poorly competitive in Bangladesh, India and the Philippines, but relatively more competitive in China and Thailand. Marketing channels are generally short

due to the perishable nature of the product, but relatively longer in Bangladesh and Thailand. Marketing functions are smoother in Thailand as compared to Bangladesh.

Marketing infrastructures are poor in Bangladesh and India and fairly reasonable and hygienic in China, Thailand and the Philippines. Transport appears to be a very big problem for the movement of fish from the producing centres or assembly points to other parts (markets) in Bangladesh and India. This is worse in remote villages with poor road connections with urban markets. Most rural markets in Bangladesh and India operate under the open sky without any facilities for stalls, electricity, water and parking. Barriers to entry are present in Bangladeshi and Indian fish markets, particularly at the primary assembly points. Producers' bargaining power is low in Bangladesh and India as compared to other countries. Intermediaries operating at the primary markets tend to cheat producers by agreeing fish prices among themselves. There is no apparent transparency in price negotiation in Bangladeshi, Indian and Filipino fish markets. Marketing margins are usually high in fish trading. In general, the producers' share in the price paid by the consumer is more than 50%.

Flow of institutional credit for production and marketing of fish is low in most of the countries, mainly because it is dominated by the private sector, although influential and big farmers do get production credit from institutional sources. Market intermediaries usually provide marketing credit. The intermediaries often also provide production credit to the producers linked with marketing. The aqua producers receiving production credit from the intermediaries are obliged to sell their produce to the supplier of credit, who often pays slightly less than the market price. Loans for investment in fisheries infrastructure, such as fish factories, processing plants and transport are usually provided by the public sector.

The common constraints faced by freshwater fish farmers in most of these countries, and especially in Bangladesh and India, include: pluralities of ownership, lack of credit facilities, lack of technical know-how, illegal poaching, deliberate poisoning and inadequate marketing opportunities. In addition, problems like multiplicity of pond ownership, non-recognition of aquaculture as a land-based activity, the absence of long-term leasing policies and non-assurance of seed supplies at appropriate times constrains the receipt of credit in India. In addition, the country is to some extent characterized by a social taboo against stocking community ponds. In general, common water bodies have been shrinking through degradation, encroachment and siltation, and industrial pollution is another problem for fish culture.

7.2 Conclusions and policy recommendations

As in other parts of the world, freshwater aquaculture is of major importance to these countries. It contributes to higher fish production, increasing supplies of animal protein and generation of employment, and is also a means of improving farm income. It has been recognized that freshwater aquaculture can make a significant contribution to bridging the widening gap between demand for and supply of fishery products in Asia, in the face of declining capture fisheries production and growing populations. It is therefore vital for these countries to review and formulate policies for the sustainable development of aquaculture. These policies should relate to the use of natural resources, research, inputs and outputs and pricing, and they should also be able to address the problems in marketing, credit, trade, investment and exchange rates.

7.2.1 Policies governing the use and management of natural resources

These countries have the natural resources necessary for aquaculture development. Moreover, many ponds and other closed water bodies remain unutilized or under-utilized, and these need to be brought under culture. Untapped water resources should be utilized by expanding integrated fish culture in paddy fields, and cage and pen culture in countries like Bangladesh, India and Thailand. In the Philippines, of the total 106 328 ha of freshwater culture area, only 14 531 ha is utilized for production (Olalo, 2000). Plurality of ownership for closed water bodies that is hindering fish culture should be settled (in Bangladesh and India). Policy measures should also be implemented to ensure equitable access to land and water resources by various groups.

Protecting cultured water bodies from floods is very important for countries like Bangladesh and India. In all countries, water pollution due to discharge of industrial toxic pollutants needs to be minimized if it cannot be stopped. Water use conflicts between crops and aquaculture should be minimized as far as possible. Fertilizers and agro-chemicals should be used judiciously use on crops to protect the natural habitats of fish.

Some countries still have extensive and traditional fish culture practices (Bangladesh, India, and Thailand). Intensive use of inputs should be encouraged to bring all ponds at least under semi-intensive fish culture. Although culturally important, the unscientific beliefs and practices that hinder best use of water bodies for fish culture need to be resolved. Regulations prohibiting culture of species such as tilapia (in India) and African magoor (in Bangladesh) merit careful attention as they could contribute greatly to the fish production. The challenge lies in devising policies to rationalize the present and future use and management of natural resources for aquaculture production, consistent with the development goals of the these countries.

7.2.2 Credit, marketing and infrastructure development

Considerable public investment in infrastructure, capacity building and institutional strengthening is needed for sustainable development of aquaculture in most of these countries. The flow of production credit from institutional sources needs to be increased for the poor fish farmers. The traditional credit system should provide not only lending services but also marketing services, such as product collection, preservation, processing and distribution, without lowering the unit price of harvest. Appropriate programmes that serve these functions need to be devised.

Marketing infrastructures, including physical space in fish markets, need to be provided (Bangladesh, India). Standardization in weighing, open-price bidding (auctioning), quality control measures, necessary grading and pricing and display of prices all need to be introduced. Use of refrigerated transport for carrying fish, as well as adequate icing facilities at markets should be provided in order to reduce spoilage, provide quality fish to the consumers and help producers obtain higher market prices.

7.2.3 Exchange rate policy

A competitive exchange rate is crucial in sustaining the growth and expansion of the aquaculture sector in these countries. Based on a comparative analysis of exchange rates in Bangladesh, the Philippines and Thailand, Dey and Bimbao (1998) reported that many developing countries in Asia need to devalue/depreciate their currency to remain competitive in the export markets. In the context of freshwater aquaculture, where most of the fish are not exportable, the concern is for these countries to remain productive and for expansion of production to remain economically advantageous. It was reported that the high breakeven price in Indonesia was an effect of Indonesian Rupee devaluation during that period, brought about by the Asian financial crisis.

7.2.4 Aquaculture research policy

Research aimed at increasing productivity and sustaining productivity gains in the long run to meet the demand of the growing population should be continued. In order to improve poor people's access to fish consumption, development studies of fast-growing and disease-resistant species should also be continued. Research on fish nutrition should be undertaken in order to develop cheap but quality feed. Identification of potential future constraints to sectoral growth is an equally important area of research.

There is a dearth of fisheries statistics in Bangladesh and India in particular, where serious attention needs to be given to generating missing information and updating old statistics. Also, it has been acknowledged that, given the current capacity of national institutions not only in these countries but also in neighbouring countries, it is clearly not possible to carry the entire gamut of research needed in a decentralized fashion. This implies that system-based networking would be appropriate, as suggested by Dey and Bimbao (1998). Collaboration on capacity building and sharing of information and experiences between research institutions and between countries must be initiated. Policies to foster

collaboration among national, international and donor country research centres need to be formulated and nurtured. Policy guidelines involving the participation of the private sector in research areas like fish marketing and processing should also be drawn up and followed through.

For countries like the Philippines, Thailand and Indonesia, where marine fish comprises a significant portion in the total fish consumption, opportunities exist for introducing value-added aquaculture products, and also for marketing and processing initiatives to make more use of under-utilized freshwater species and to optimize allocation of raw materials and supplies (Tietze, 1995). The Bureau of Fisheries and Aquatic Resources (BFAR) of the Philippines for example, has successfully used bighead carp as raw material for artificial crab legs, a surimi product that is very popular in sushi bars (Yap, 1997; Olalo, 2000). Such undertakings provide employment and added income, particularly for women.

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9. TABLES AND FIGURES

Table 1. Freshwater fish production from aquaculture of the selected countries and the world (t)

Year	Bangladesh		China		India		Indonesia		Philippines		Thailand		Viet Nam		World
1989	156 333	(2.16)	4 170 030	(57.69)	976 500	(13.51)	197 695	(2.74)	77 842	(1.08)	91 491	(1.27)	120 187	(1.66)	7 228 143
1990	165 087	(2.16)	4 459 100	(58.47)	982 136	(12.88)	212 821	(2.79)	81 126	(1.06)	97 659	(1.28)	112 076	(1.47)	7 626 007
1991	182 493	(2.32)	4 625 900	(58.68)	1 185 261	(15.04)	194 351	(2.47)	87 844	(1.11)	122 936	(1.56)	111 504	(1.41)	7 882 616
1992	189 863	(2.14)	5 337 900	(60.11)	1 348 644	(15.19)	212 937	(2.40)	116 439	(1.31)	141 606	(1.59)	110 099	(1.24)	8 880 924
1993	191 698	(1.90)	6 472 599	(64.23)	1 354 702	(13.44)	245 100	(2.43)	113 663	(1.13)	161 630	(1.60)	120 061	(1.19)	10 077 785
1994	218 048	(1.87)	7 896 594	(67.85)	1 436 628	(12.34)	255 308	(2.19)	119 888	(1.03)	177 790	(1.53)	149 556	(1.29)	11 638 587
1995	269 742	(1.98)	9 407 600	(69.15)	1 588 799	(11.68)	279 845	(2.06)	97 664	(0.72)	200 782	(1.48)	370 128	(2.72)	13 605 534
1996	302 140	(1.96)	10 989 505	(71.38)	1 688 330	(10.97)	328 763	(2.14)	91 233	(0.59)	229 266	(1.49)	348 649	(2.26)	15 396 066
1997	347 197	(2.04)	12 366 559	(72.72)	1 795 240	(10.56)	292 288	(1.72)	105 425	(0.62)	240 118	(1.41)	342 622	(2.01)	17 006 425
1998	420 162	(2.32)	13 219 136	(73.01)	1 946 809	(10.75)	276 047	(1.52)	86 880	(0.48)	240 001	(1.33)	359 000	(1.98)	18 105 203
1999	512 134	(2.64)	14 219 740	(73.33)	1 919 565	(9.90)	289 550	(1.49)	97 276	(0.50)	256 417	(1.32)	407 820	(2.10)	19 390 284
Growth rate	11.70		13.86		2.24		4.70		1.18		10.85		15.97		11.00

NOTE: Figures in parenthesis indicate percentage of world freshwater fish production from aquaculture.

SOURCE: FAO 2000. Fisheries Statistics (http://www.fao.org/)

Table 2. Sectoral contribution to Gross Domestic Product and composition of fishery

Country	Agricultural contribution (%) to GDP (1999)[1]	Fisheries contribution to GDP[2]	Fisheries contribution to employment	Fish production	Fishery composition
Bangladesh[3]	25.2% (declining)	3.10% (increasing)	1.2 million (full-time) 11 million (part-time)	1.55 million t Inland capture: 41.83% Inland culture: 38.21% Marine capture: 19.96%	Inland capture Inland culture Marine industrial Marine artisanal
China[4]	17.3% (declining)	10% (increasing)	36 million[5] 15 million full-time 13 million part-time 8 million occasional	36.01 million t Culture: 56.3% Capture: 43.7	Marine capture Marine culture Freshwater capture Freshwater culture
India[6]	27.9% (declining)	4.6% (increasing)	6 million (in production) 4 million (in marketing)	4.94 million t (total) culture: 33% capture 67%	Freshwater aquaculture Coastal culture Inland capture Marine capture
Indonesia	19.4% (declining)	1.59% (increasing)	1.06 million (full-time) 720 000 (part-time major) 310 000 (part-time minor)	4.40 million t total fish catch production marine fish production: 66.99%	Freshwater aquaculture Marine capture Coastal brackish water culture Inland capture
Philippines[7]	17.6% (declining)	4.45%	1 million 70% municipal 25% aquaculture 5% commercial	2.65 million t (total) Aquaculture: 29% Municipal fisheries: 39% Commercial fisheries: 32%	Commercial fishery Municipal fishery Brackish water aquaculture Freshwater aquaculture Mariculture

Thailand[8]	10.4% (declining)	1.9% (declining)	110 000 in Marine fishery of which 50 000 capture 30 000 coastal aquaculture 3 000 both in marine capture and coastal aquaculture	3.5 million t marine capture: 79.3%, coastal aquaculture: 10% freshwater aquaculture 5.9% inland capture: 5.8%	Freshwater culture Coastal culture Inland capture Marine capture
Viet Nam	26.4% (declining)	3% (increasing)	3.03 million	1.55 million t total fish catch production marine fish production: 43.21%	Freshwater aquaculture Marine capture Coastal culture Inland capture

SOURCES: (1) Key indicators of developing Asian and Pacific countries 2000, volume XXXI, Asian Development Bank, http://www.adb.org/Documents/Books/Key_Indicators/2000/. (2) FAO 2000 (http://apps1.fao.org/). (3) Alam, 2000. (4) Huang *et al.,* 2000. (5) Bhatta, 2000. (6) Olalo, 2000. (7) Piumsombun, 2000. (8) The state of the world fisheries and aquaculture, Part 1. World review of fisheries and aquaculture fisheries 2000. http://www.fao.org/docrep/003/x8002e/x8002e04.htm

Table 3. Socio-demographic characteristics of freshwater fish producers in Asia

Parameter	Bangladesh	China	India	Indonesia		Philippines		Thailand	Viet Nam	
				RWS	Cage	Pond	Cage		North	South
Sampled farm households	540	383	409	40	71			284	158	240
Age (years)	45		47	46.55	40.87	47.00	46.00	49.77	43	52
Gender (%)										
Male	100	100	87			95	94	95.10	43.90	51.4
Female			13			5	6	4.90	56.10	48.6
Education (years)	8	12	7.42	7.43	8.07	6	7	4.35	8.80	6.00
Illiterates (%)	11		32.70					1.80		4.35
Primary Occupation (%)										
Fish culture	9.0	100	43.7	92.5	94.4			20.1	2.00	7.90
Crop farming	65.0		41.1	2.5	1.4			60.6	87.4	44.6
Animal husbandry	2.0		2.2		4.2			7.0	10.6	0.8
Others	24.0		12.5	5.0				12.3		46.70
Experience in fish farming (years)	13	15	6	13	5				10	7
Gross household income (US$)	1 612	17 321[1]	8 907					11 272	2 878	3 142
Income Sources (%)										
Fish culture	14.93	64.00	79.66			30	60	20.01	27.6	27.58
Crop farming	28.93	3.00	13.10			19	8	13.03	29.4	58.15
Animal husbandry	3.19	3.00	0.03			33	1	48.41	27.30	14.20
Hatchery and seed production		20.00	6.35						6.20	
Business and salaries	32.55	6.00	0.55						7.40	
Others	20.00	4.00				18	11	18.55	0.10	0.08
Average household size (number)	5.5	3.5	8.00	3.35	3.73	5	6	4.65	5.00	5.81

SOURCES: For Philippines: Dey *et al*., 2000 and DEGITA field survey 1995-1996. For other countries, Surveys of carp producers and consumers 1998-1999.

NOTES: (1) Gross income for China refers only to family-based farms. The average gross income of cooperative and state-owned farms ranges from US$ 53 179 to US$ 149 135

Table 4. General characteristics of freshwater farming in Asia

Items	Bangladesh	China	India	Indonesia		Philippines		Thailand	Viet Nam	
				RWS	Cages	Pond	Cages		North	South
Total Area (ha)		3.59[1]	4.24	2.29	2.87	4.91	1.260	3.98	3.67	1.04
Crop land (%)		8.55[2]	24.76			45.80	38.10	50.80	43.30	80.69
Water spread area (%)		83.11	44.85			-	-	26.04	47.9	18.11
Fish-pond area (%)		17.95	23.51			30.80	42.90	25.63	31.60	7.94
Homestead area (%)			1.20			13.60	5.60	5.06	4.80	3.40
Animal farming			5.45			9.80	13.40	0.73	3.90	
Unutilized area			0.25					4.40		
Garden										

Others										
Size of the fish pond (ha)	0.20	1.70	0.87			1.56	1.54	1.21	1.16	0.82
Fish farm area by tenure (%)										
Privately owned	100	41.10	62.6	100	100	75.00	99.00	90.10	35	95.70
State owned		29.60	29.30			25.00	1.00	0.70	45	0.57
Collective		29.30	2.20					8.50	17.8	3.73
Rented in			6.80					0.70	2.2	
Others			1.20							
Type of operation (%)										
Single ownership	86.70	100	71.00	100	100	87.00	71.00	85. 40	88	99.12
Joint ownership	13.30		26.90			13.00	29.00	14. 60	22	0.88
Lease operated										
Minimum water depth (m)	2.28	2.10	3.00	0.90	2.04					
Dry season	1.30		2.90			0.90	4.20	1.27	1.56	0.93
Wet season	4.25		4.78			1.30	5.60	2.12	2.44	1.37
Farming duration (months)	9-12	8-11	8-12	3-4	3-4			5-12		
Rearing type (%)										
Seasonal	26.30		13					8.50	8.10	41.42
Perennial	73.70	100	87	100	100	100	100	91.50	91.90	58.48
Pond system										
Monoculture		4.20								
Polyculture		92.30				100	100	8.50	1.80	30.50
Mono + Polyculture	100	3.50	100	100	100			91.50	98.20	69.50

SOURCES: For Philippines: Dey *et al*., 2000, and DEGITA field survey 1995-1996. For other countries: Surveys of carp producers and consumers 1998-1999.

NOTES: (1) The average total area refers to small-scale farms. For large-scale state-owned farms it is 131.80 ha. (2) The percentage of pond area refers to the water-spread area.

Table 5. Freshwater-fish-species cultured in Asia

Items	Bangladesh	China	India	Indonesia		Philippines		Thailand	Viet Nam	
				RWS	Cage	Pond	Cage		North	South
Average stocking Density (no. of fish/ha[1])	10 261	26	18 408	56.5	136.56	35 900	6 757	67 328	5 432	136 406
Share of different species (%)	24.10	470	31.00					4.93	22.90	0.11
Rohu	16.13	19.73	26.06	100	100			4.47	7.40	0.01
Catla	16.45	12.27	17.77					8.37	4.90	2.68
Mrigal	2.21	17.41	6.44			100	100	39.88	8.70	17.30
Common carps	2.80	5.97	4.18						28.10	1.54
Grass carps	19.68	5.53	7.17					36.76	2.30	2.83
Chinese carps	13.04	34.53						4.26		20.00
Silver carps	0.55	0.21							25.70[2]	4.33
Silver barb	2.28	4.35	6.85							
Kalbasu	2.74									51.20[2]
Big head carps										
Chinese bream										
Crucian carp										
Mirror carps										
Black carps										
Tilapia										
Others										
Sources of fingerlings (%)										
Own	5	90	0.54	2.50	5.72	10	100	4.03	23.60	2
Private hatchery	40	10	61.85	42.50	13.46	47		74.20	54.50	79
Government hatchery	20		25.00	55.00	48.08	43		21.77	7.90	11
Middlemen and others	35		13.00		32.09				13.80	8

SOURCES: For Philippines: Dey *et al*., 2000, and DEGITA field survey 1995-1996. For other countries: Surveys of carp producers and consumers 1998-1999.

NOTES: (1) For Indonesia, stocking density is in kilograms per 100 m^2. (2) Including tilapia.

Table 6. Input output used by freshwater fish producers in selected Asian countries

Category	Bangladesh	China	India	Indonesia		Philippines[1]		Thailand	Viet Nam North
				RWS	Cage	Pond	Cage		
Yield (kg/ha)	3 262.11	12 085.20	3 214.07	481.68	1 009.52	2 959	540	3 779.71	3 647.00
Seed or Fry (pieces/ha)(1)	10 261.00	27 867.00	18 408.00	56.50	136.57	23 700	6 757	67 328.00	5 432.00
Feed	2 232.37	38 251.05	9 035.80	807.99	1 493.90			10 989.48	1 724.50
Rice bran (kg/ha)	1 727.70	442.50	8 243.52			3 172		2 019.92	1 724.50
Commercial feed (kg/ha)		19 219.80		807.99	1 493.90	2 336	533	1 229.13	
Oil cake (kg/ha)	504.67	16 380.00	474.00						
Other		2 208.75	318.28					7 740.43	
Fertilizer	725.22	2 292.60	5 606.96	-	-			2 909.58	1 875.00
Organic (kg/ha)	438.86	1 170.75	5 469.93			7 175		2 680.90	1 875.00
In organic (kg/ha)	286.36	1 121.85	137.03			213		228.68	
TSP	65.30								
Urea	221.06	150.00	55.99						
Other		971.85	81.04	-	-				
Lime	92.99							285.03	65.00
Medical/Chemical/Pest.		1 353.60	18.54	-	-			1.70	
Labour (workdays)	323.52	292.51	277.27	64.80	187.20			159.21	132.60
Family labour	184.41		150.21			29	11		122.00
Hired labour	139.11	292.51	127.06			41	12		10.60

SOURCE: For Philippines: Dey *et al*,. 2000, and DEGITA field survey 1995-1996. For other countries: Surveys of carp producers and consumers 1998-1999.

NOTES: (1) Seed is in kg/ha for China, kg/100m^2 for Indonesia, while the others are in piece/ha.

Table 7. Costs and Returns of carp fish producers in participating countries, 2000 (US$/ha(1))

Category	Bangladesh	China(2)	India	Indonesia		Philippines		Thailand	Viet Nam North
				RWS	Cage	Pond	Cage		
Gross returns	1 715.12	10 797.11	2 124.53	506.89	872.97	4 969	913	2 343.42	2 374.07
Average price of fish produced	0.53	0.89	0.66	1.05	0.86	1.68	1.69	0.62	0.65
Yield (kg/ha)	3 262.11	12 085.20	3 214.07	481.68	1 009.52	2 959	540	3 779.71	3 647.00
Variable costs	611	7 349	1 535	352	697	2 643	418	873	976
Seed/Fry	84.48	2 153.82	777.6	84.17	202.93	343	113	195.85	246.4
Feed	124.27	3 750.35	248.43	242.27	389.72	1 552	232	390.09	281.2
Rice bran	59.65		179.21			571	10	153.31	267.9
Commercial feed						981	222	179	
Oil Cake	64.62		29.94						
Other			39.28					57.78	13.3
Fertilizer	69.33	146.59	88.42			408		60.42	87.1
Organic	30.35		66.21			119		101.27	
In organic	38.98		22.21			289		81.62	87.1
Lime	10.22					53		6.12	7.6
Medical/Chemical/Pest.		156.94	45.73	0.3	1.49	41		1.42	118.3
Labour	322.82	731.27	375.04	25.02	102.34	218	72	167.35	234.70
Family labour	176.35		194.87			90	34	155.02	215.94
Hired labour	146.47		180.17			128	37	12.33	18.76
Fuel/Electricity		288.23						17.57	
Other	0.18	121.83		0.23	0.67	28	1	33.9	0.20
Total Cost	611.30	7 349.03	1 535.22	351.99	697.15	2 643.00	417.80	872.72	975.50
Operating profit(3)	1 103.82	3 448.08	589.31	154.90	175.82	2 326.00	495.20	1 470.70	1 398.57
Rate of return over variable cost (%)	280.57	146.92	138.39	144.01	125.22	188.01	218.53	268.52	243.37
Ratio of operating profit to variable cost	1.81	0.47	0.38	0.44	0.25	0.88	1.19	1.69	1.43
Cost per kg (Variable cost/yield)	0.19	0.61	0.48	0.73	0.69	0.89	0.77	0.23	0.27

NOTES: All figures are average of each country figure and values are in US$/ha, but Indonesia's figures are in US$/100 m^2, as are Philippines' cage values. (1) Exchange rates: US$ 1.00 = Tk 49 (Bangladesh); RMB¥ 8.1 (China); Rs 46 (India); Rp 7 000 (Indonesia); p 27 (Philippines -1995-996); B 38 (Thailand); and D 14 000 (Viet Nam). (2) Average farm-gate price was calculated from survey data (RMB¥ 7/kg) and average inputs and output were calculated from China's country report. (3) Operating profit = Total revenue - Variable cost.

SOURCES: For Philippines: Dey *et al.*, 2000, and DEGITA Field survey 1995-1996. For other countries: Carp genetics field survey, 1997.

Table 8. Total factor productivity of carp polyculture production in selected Asian countries, 1998-99.

	Bangladesh	China	India	N. Viet Nam
% Difference in cost (US$/ha)	70.05	842.08	175.91	111.78
% Difference in production value (US$/ha)	73.19	460.74	90.66	101.31
% Difference in production quantity (US$/ha)	86.31	330.55	85.03	96.49
% Difference in weighted input prices	152.69	274.65	253.65	397.25
Productivity index based on production value:				
Cost index	0.63	0.67	0.76	0.28
Production index	1.60	1.50	1.31	3.60
Productivity index based on production quantity:				
Cost index	0.53	0.93	0.82	0.29
Production index	1.88	1.08	1.23	3.43

NOTE: Thailand is used as the reference country.

Table 9. Trends in consumption of fish and fishery products and contribution of fish to animal protein supply

	Bangladesh(1)	China	India	Indonesia	Philippines	Thailand	Viet Nam
Animal protein (g/caput/day)							
1997	6.1	26.2	9.8	12.1	25.8	24.6	13.1
1990	4.9	13.6	8.5	12.9	24.0	17.7	9.6
1980	4.5	6.9	6.7	7.0	21.0	14.5	7.2
Average (1961-97)	5.28	9.55	7.23	7.28	20.61	16.37	9.66
Growth rate (1961-97)	-0.09	4.77	1.52	2.95	1.28	1.84	0.44
Fish protein (g/caput/day)							
1997	3.0	6.0	1.5	6.4	11.1	10.2	5.2
1990	2.1	2.7	1.1	5.1	13.3	5.9	3.2
1980	2.2	1.2	0.9	4.2	11.2	5.3	2.9
Average (1961-97)	2.48	2.15	0.92	4.21	11.33	6.32	4.21
Growth rate (1961-97)	-0.44	3.10	2.17	2.50	1.10	1.94	-0.97
Share of fish in total animal protein (%)							
1997	49.2	22.9	15.3	52.9	43.0	41.5	39.7
1990	42.9	19.9	12.9	54.8	55.4	33.3	33.3
1980	48.9	17.4	13.4	60.0	53.3	36.6	40.3
Average (1961-97)	46.85	24.19	12.61	58.78	55.11	38.11	43.66
Growth rate (1961-97)	-18.05	-43.43	7.38	-24.28	-8.42	12.61	-60.35

SOURCE: Laureti, E. (comp.) 1961-1997. Fish and fishery products: world apparent consumption statistics based on food balance sheets. *FAO Fisheries Circular*, No. 821, Rev. 5.

NOTES: In live weight. (1) For Bangladesh, averages and growth rates are from 1972 to 1997.

Table 10. Trends in per caput fish consumption in selected Asian countries

	Per caput annual consumption			Average (1961-98)		Average annual growth rate	
	1998	1990	1980	Consumption	Proportion	Consumption	Proportion
Bangladesh							
All species, of which:	10.4	7.4	7.2	8.82	-	-0.36	-
Freshwater fish	8.5	6.0	5.9	7.50	84.70	-0.61	-0.25
Demersal fish	0.4	0.3	0.4	0.36	4.10	-0.22	0.14
Pelagic fish	0.3	0.4	0.4	0.27	3.23	3.77	4.13
Other marine fish	0.2	0.4	0.4	0.42	4.86	-2.05	-1.69
Crustaceans	1.0	0.3	0.1	0.26	2.95	4.09	4.46
Molluscs	0.1	0.1	0.0	0.02	0.00	8.97	9.33
China							

All species, of which:	25.7	11.5	5.2	9.04	-	4.55	-
Freshwater fish	10.6	4.5	1.3	3.03	29.39	6.57	2.02
Demersal fish	1.5	0.6	0.5	0.62	7.76	3.00	-1.54
Pelagic fish	1.6	1.0	0.9	1.01	14.03	1.32	-3.22
Other marine fish	2.9	2.1	1.2	1.78	23.84	1.74	-2.80
Crustaceans	2.2	0.9	0.5	0.79	8.91	4.58	-0.07
Cephalopoids	0.4	0.1	0.1	0.16	1.53	-	-
Molluscs	6.4	2.2	0.5	1.67	14.55	7.99	3.34
India							
All species, of which:	4.6	3.8	3.1	3.21	-	1.94	-
Freshwater fish	2.5	1.9	1.3	1.49	45.58	2.66	0.07
Demersal fish	0.9	0.7	0.6	0.66	21.03	1.54	-0.04
Pelagic fish	0.6	0.7	0.7	0.71	23.17	-0.28	-2.22
Other marine fish	0.4	0.3	0.2	0.20	5.86	8.50	6.56
Crustaceans	0.2	0.2	0.3	0.21	6.52	1.84	0.10
Cephalopoids	0.0	0.0	0.0	0.04	1.36	-	-
Molluscs	0.0	0.0	0.0	0.00	0.03	-	-1.94
Indonesia							
All species, of which:	17.9	14.7	11.7	12.45	-	1.95	-
Freshwater fish	4.5	3.7	2.8	3.49	29.13	0.22	-1.73
Demersal fish	2.5	1.8	1.5	1.38	10.63	4.01	2.05
Pelagic fish	8.5	7.2	5.0	5.33	41.45	3.50	1.54
Other marine fish	0.6	1.0	1.3	1.28	11.32	-2.27	-4.22
Crustaceans	1.3	0.8	0.7	0.72	5.60	3.47	1.52
Cephalopoids	0.2	0.1	0.1	0.10	0.82	-	-
Molluscs	0.3	0.1	0.2	0.15	1.12	1.70	15.03
Philippines							
All species, of which:	29.6	36.5	31.3	31.69	-	0.83	-
Freshwater fish	4.1	6.0	4.8	4.67	14.60	1.48	0.65
Demersal fish	3.7	5.5	5.4	5.51	17.55	-0.31	-1.14
Pelagic fish	17.7	19.8	15.3	17.49	55.45	0.48	-0.35
Other marine fish	0.1	0.5	0.2	0.48	1.52	-3.32	-4.15
Crustaceans	1.3	1.0	0.9	1.14	3.60	2.55	1.72
Cephalopoids	0.9	0.6	0.7	1.83	1.76	-	-
Molluscs	1.7	3.1	4.1	0.55	5.45	2.98	28.93
Thailand							
All species, of which:	33.1	20.0	18.0	21.33	-	2.05	-
Freshwater fish	8.1	4.0	3.0	3.73	17.59	2.62	0.56
Demersal fish	4.2	1.3	1.8	1.86	8.00	6.82	4.77
Pelagic fish	11.9	9.1	5.7	6.56	28.91	6.35	4.30
Other marine fish	0.1	0.2	1.9	3.05	16.32	-8.75	-10.80
Crustaceans	4.1	2.2	2.8	2.42	11.46	1.68	-0.38
Cephalopoids	2.0	0.9	0.5	2.73	4.33	-	-
Molluscs	2.7	2.4	2.5	1.00	13.45	0.79	-1.26
Viet Nam							
All species, of which:	17.1	12.7	10.4	14.21	-	-0.44	-
Freshwater fish	5.7	3.3	3.0	3.71	26.70	0.43	0.87
Demersal fish	0.0	0.0	0.0	0.00	0.00	-	0.44
Pelagic fish	0.0	0.0	0.0	0.01	0.03	3.22	3.67
Other marine fish	7.7	6.2	6.0	8.53	59.20	-1.98	-1.52
Crustaceans	3.8	2.7	0.9	1.54	10.99	4.88	5.33
Cephalopoids	0.0	0.1	0.2	0.26	0.96	--	-
Molluscs	0.1	0.4	0.3	0.13	1.98	15.51	16.36

SOURCE: FAO Food Balance Sheet database [http://apps.fao.org/]

Table 11. Consumer prices (US$) of different fish species in selected Asian countries.

Species	Bangladesh	China	India	Philippines	Thailand	N. Viet Nam	S. Viet Nam
Rohu	1.44		0.85			0.61	
Catla	1.20		0.86				1.47
Mrigal	0.94		0.80			0.72	0.64

Silver carp	0.81	0.65					0.62
Common carp		1.07	0.65		0.90	0.82	0.77
Bighead		0.86				0.56	
Black carp		1.28				1.38	
Chinese bream		1.30					
Crucian carp		1.30					
Grass carp		1.06				0.67	0.50
Silver barb	0.77				0.72	0.41	0.84
Other (exotic) carps	0.93		0.89				
Tilapia	0.84			1.94	0.69	0.66	0.65
River shad	1.42						
Assorted small fish	0.82						
Live fish	1.61						
High-valued fish	1.74						
Milkfish				2.70			
Bisugo				2.27			
Bonito				3.05			
Hybrid catfish				2.26			
Dried fish					2.40	0.84	1.17
Snake head					1.70		1.21
Catfish					0.74		
Puntius alstus							1.07
Kissing gourami							0.62
Climbing perch							0.71
Sand goby							0.73
Pangasius bocourti							1.23
Pangasius siamensis							1.22
Clarias catfish							1.01
Rasbosa							0.43
Mystus							0.61
Other freshwater fish			0.35				
Other marine fish		1.27(1)	1.17	2.01(2)	2.15	0.72	0.61
Other fish		1.70		1.70(2)	1.05	1.28	

SOURCES: For Philippines: DEGITA field survey 1995-1996. For other countries: Surveys of carp consumers 1998-1999.

NOTES: (1) average price of butterfish, hairtailed and longtailed fish (Dey *et al*., 2000). (2) Olalo, 2000.

Table 12. Proportion and per caput fish consumption in selected Asian countries

Species composition															
Bangladesh		**China**		**India**		**Indonesia**		**Philippines**		**Thailand**		**N. Viet Nam**		**S. Viet Nam**	
Rohu	9.33	Grass carp	20.9	Marine fish	36.43	Marine fish	9.00	Tilapia	40.18	Tilapia	29.58	Rohu	27.5	Snakehead	27.
Catla	6.79	Crucian carps	20.1	Common carp	19.20	Common carp	4.80	Bagrus	12.21	Silver barb	16.25	Grass carp	20.9	Marine fish	15.
Mrigal carp	5.72	Silver carp	15.6	Mrigal	4.42	Tilapia	2.40	Bisugo	6.17	Snakehead	15.42	Silver carp	15.3	Silver barb	6.
Silver carp	14.13	Common carp	12.4	Common carp	2.04	Catfish	0.50	Hito/catfish/kanduli	1.27	Walking catfish	10.42	Tilapia	10.5	Walking catfish	5.
Silver barb	5.60	Bighead	9.8	Exotic carps	3.34	Others	83.30	Bonito	0.44	Marine fish	8.33	Common carp	10.0	Dryfish	4.
Other (exotic) carps	6.11	Black carp	7.3	Other freshwater	16.98			Other freshwater	7.31	Dryfish	7.50	Dried fish	3.2	Rohu	2.
Tilapia	2.47	Chinese bream	6.6	Other marine	16.94			Other marine	31.85	Common carp	1.67	Bighead	1.5	Tilapia	2.
River shad	9.66	non-carps	7.4							Other freshwater	10.83	Black carp	0.6	Common carp	1.
Live fish	10.84											Mrigal	0.3	Silver carp	1.
High-valued fish	5.74											Others	10.2	Mrigal	0.
Assorted fish	23.61													Grass carp	0.
														Others	32.

Consumption (kg/caput/yr)	19.92		31.08		15.00		15.81		44.05		28.80		12.86		37.8

Sources: For Philippines: DEGITA field survey 1995-1996. For other countries: Surveys of carp producers and consumers 1998-1999.

Table 13. Percentage of each species in total fish expenditure by income class.

Species	Income quartile				
	Average	I	II	III	IV
Bangladesh					
Rohu	11.8	11.2	12.5	12.1	11.4
Catla	7.7	7	6.9	7.9	8.3
Mrigal	4.6	4.4	4.7	4.5	4.7
Silver carp	9.3	11.5	10.3	9.7	7.7
Silver barb	3.8	3	3.6	4.1	4
Other (exotic) carp	5.8	4.7	5.6	5.5	6.5
Tilapia	1.9	2.7	2.4	1.9	1.4
River shad	12.9	14.1	14.6	12	12.2
Live species	16	14	13.4	15.3	18.5
High valued species	9.5	9.1	9.4	10.5	9.2
Assorted small fish	16.7	18.2	16.6	16.5	16.1
China					
Crucian carp	23.6	24.4	22.6	23.4	23.9
Grass carp	20.0	14.7	14.7	18.7	23.5
Common carp	12.0	17.3	15.3	12.1	9.9
Silver carp	9.2	16.3	12.4	9.2	6.9
Black carp	8.4	5.5	7.2	10.4	8.3
Bighead carp	7.6	6.9	9.6	8.2	6.8
Others	11.3	7.9	9.5	8.3	14.3
India					
Rohu	36.3	35.1	35.2	41.4	34.7
Catla	19.4	20.7	24.9	23.7	14.3
Mrigal	4.4	8.3	6.2	3.8	1.9
Common carp	1.6	0.2	2.3	3.8	0.7
Other (exotic) carps	3.5	9.9	4.3	2.9	1.4
Other freshwater fish	8.6	9.2	11.4	10.1	6.6
Other marine fish	26.2	16.7	15.8	14.0	40.4
Thailand					
Tilapia	17.8	24.7	19.8	18.9	12.7
Snakehead	22.8	24.9	25.5	25.5	18.3
Silver barb	10.2	20.7	12.8	10.5	4.2
Walking catfish	6.8	6.9	7.1	7.0	6.4
Common carp	1.2	2.0	1.6	1.5	0.5
Other Freshwater	10.1	9.5	10.2	7.8	12.1
Marine fish	15.3	3.1	10.8	14.2	23.8
Dried fish	15.8	8.2	12.2	14.6	22.0
Northern Viet Nam					
Rohu	25.1	23.6	26.5	21.4	27.6
Common	12.2	5.6	7.9	18.6	12.1
Tilapia	10.3	9.9	7.9	10.9	11.4
Silver carp	9.4	12.3	12.1	8.5	7.7
Mrigal	5.7	16.6	7.8	2.2	3.8
Bighead	1.2	0	2.4	0.3	1.7
Black	1.1	1.4	2.5	0	0.9
Dried fish	3.9	4.2	2.9	3.3	4.9
Others	9.9	7.3	11.9	12.9	7.4
Southern Viet Nam					
Snakehead	37.4	34.5	34.1	36.6	39.9
Walking catfish	6.0	7.6	5.0	6.2	5.8
Silver barb	5.8	4.3	5.3	5.8	6.5
Rohu	2.3	0.1	2.4	2.3	3.0

Common carp	1.7	5.2	1.1	1.6	0.8
Tilapia	1.6	1.9	0.8	2.7	1.1
Silver carp	0.7	0.1	1.6	0.9	0.5
Mrigal	0.3	0.0	0.5	0.5	0.1
Marine fish	11.0	11.1	13.6	11.6	9.8
Dried fish	5.5	0.1	4.1	6.4	7.2
Others	27.7	35.1	31.5	25.4	25.3

Table 14. Annual fish expenditure by income classes

Income Quartile	Country							
	Bangladesh	China	India	Indonesia	Philippines	Thailand	N. Viet Nam	S. Viet Nam
Per caput total annual expenditure(US$)								
I		60.00	90.84	63.72	151.58	219.48	40.68	27.29
II		97.20	158.04	106.44	255.96	343.08	85.32	88.83
III		144.00	234.48	175.32	562.42	496.32	135.96	131.71
IV		314.16	876.00	409.68	1 147.73	1 032.96	355.44	270.22
All		153.84	339.84	188.76	529.42	522.96	153.96	129.29
Food expenditure as a percentage to total expenditure								
I		63.40	73.20	67.20	59.20	64.50	80.40	97.90
II		54.70	62.40	60.50	49.10	53.70	81.20	93.00
III		47.80	51.20	53.30	41.30	46.00	75.40	91.20
IV		33.20	22.20	38.20	19.21	28.00	45.70	81.90
All		43.10	35.20	47.30	42.20	40.30	59.50	87.10
Per caput total annual fish expenditure(US$)								
I	15.97	11.88	9.12	3.96	27.99	20.04	4.08	19.79
II	23.51	22.92	10.20	5.52	23.00	27.48	7.32	20.99
III	28.06	36.12	12.00	7.68	18.18	36.24	9.72	32.66
IV	41.19	66.36	24.48	11.64	37.26	47.76	13.32	61.04
All	27.19	34.32	14.04	7.20	25.42	32.88	8.64	33.57
Fish expenditure as a percentage to total expenditure								
I		19.80	10.10	6.20	23.30	9.10	10.00	72.40
II		23.60	6.40	5.20	11.73	8.00	8.60	23.60
III		25.10	5.10	4.30	4.28	7.30	7.20	24.80
IV		21.10	2.80	2.80	2.89	4.60	3.70	22.60
All		22.30	4.10	1.50	10.55	6.30	5.60	25.90
Fish expenditure as a percentage to food expenditure								
I	26.10	31.20	13.70	9.20	53.59	14.10	12.50	74.00
II	26.80	43.10	10.30	8.60	41.25	14.90	10.60	25.40
III	25.40	52.40	10.00	8.20	38.45	15.90	9.50	27.20
IV	23.90	63.40	12.60	7.40	34.75	16.50	8.20	27.60
All	25.20	51.80	11.80	8.10	42.08	15.60	9.40	29.80
Fish expenditure as a percentage to animal protein expenditure								
I	77.77	58.80	63.00		78.05	76.94	17.20	92.00
II	73.91	70.80	35.50		73.05	79.38	16.90	55.40
III	71.92	77.70	29.50		68.87	82.29	15.80	53.50
IV	68.94	85.00	30.70		48.12	72.72	15.50	51.10
All	71.89	77.60	33.50		68.15	77.50	16.00	56.10

SOURCE: For Philippines: DEGITA field survey 1995-1996. For other countries: Surveys of carp consumers 1998-1999.

Table 15. Fish consumption by individual species and by consumer types (kg)

	Bangladesh			India		Philippines			Thailand		
	Urban	Rural Producer	Non-producer	Urban	Rural	Urban	Rural Producer	Non-producer	Urban	Rural Producer	Non-producer
Total annual per caput consumption (kg)	19.92	21.36	18.36	11.13	23.16	33.9	72.6	39.7	19.92	34.92	28.68
Species (%):											
Rohu	10.05	8.95	8.98	29.40	44.94						
Catla	7.27	7.12	5.97	17.71	22.56				3.01	22.68	14.64
Mrigal	6.68	5.62	4.88	3.12	5.98						

Silver carp	13.92	14.35	14.11								
Silver barb	6.11	5.32	5.37								
Tilapia	2.63	2.22	2.57			5.80	39.50	15.90	23.49	31.62	30.54
River shad	9.54	10.03	9.41								
Assorted small fish	21.16	24.15	25.53								
Live fish	10.37	10.72	11.42								
High value fish	5.86	5.90	5.44								
Common carp				1.79	2.33				0.60	2.41	1.26
Other carps	6.39	5.62	6.31	1.64	5.40						
Milkfish						3.20	2.30	7.10			
Walking catfish									9.04	8.59	13.39
Snakehead									14.47	12.71	18.83
Other freshwater fish				24.72	7.44				10.24	12.37	9.62
Other marine fish				21.62	11.34				24.09	3.78	5.86
Dried fish									15.06	5.84	5.86
Others	31.10	35.80	34.20			24.90	30.80	16.70			

SOURCE: For Philippines, DEGITA field survey 1995-1996. For other countries, surveys of carp consumers 1998-1999.

Table 16. Consumer preferences for freshwater species in Asia

Rank/Country	Bangladesh	China	India	Indonesia	Thailand	N. Viet Nam	S. Viet Nam
1	Rohu	Crucian carp	Rohu	Common carp	Tilapia	Grass carp	Common carp
2	Catla	Grass carp	Catla		Snakehead	Mud carp	Snakehead
3	Mrigal	Common carp	Mrigal		Catfish	Common carp	Silver carp
4	Silver barb	Bighead	Common carp		Indo-Pacific mackerel	Silver carp	Climbing perch
5	Common	Chinese bream	Grass carp		Silver barb		Walking catfish
6	Mirror	Silver carp	Silver carp				Giant gourami
7	Silver carp	Black carp					*Pangasius bocourti*
8	Grass carp						*Puntius attus*
9	Kalibasu						Silver barb

Table 17. Consumer preferences for traits of preferred carp species in Asia

Bangladesh	China	India	Thailand	Northern Viet Nam	Southern Viet Nam
Rohu	Crucian carp	Rohu	Silver barb	Grass carp	Common carp
Colour	Body shape	Body shape	Higher dress-out %	Bigger size	Higher fat
Higher dress-out %	Bigger size	Better flavour	Bigger size	Higher dress-out %	Bigger size
Bigger size	Colour	Colour	Better flavour	Body shape	Colour
Catla	Better flavour	Catla	Body shape	Better flavour	Body shape
Colour	Grass carp	Bigger size		Common carp	Silver carp
Higher dress-out %	Bigger size	Higher fat		Better flavour	Colour
Mrigal	Better flavour	Better flavour		Colour	Bigger size
Higher dress-out %	Higher dress-out %	Higher dress-out %		Body shape	Body shape
Colour	Higher fat	Mrigal		Bigger size	Higher fat
	Common carp	Higher dress-out %		Silver carp	Silver barb
	Better flavour	Body shape		Higher fat	Higher fat
	Higher dress-out %	Colour		Higher dress-out %	Better flavour
	Body shape	Better flavour		Bigger size	Body shape
	Colour			Colour	Higher dress-out %

Table 18. Consumer preferences for size, shape, colour and other parts of selected carp species

	Rohu	Common	Mrigal	Silver carp	Silver barb	Catla	Grass	Crucian
Size (pcs./kg.)								
Bangladesh	<1	<1 to 1	<1 to 1	<1	2 to 3	<1	<1	
China		1 to 2		1 to 2		1 to 3	1	
India	1 to 2	1 to 2	1 to 2			1 to 2	1	
Indonesia								

Thailand	<2-3	<2-3	<2-3		<2-5			
Northern Viet Nam				2			2	
Southern Viet Nam	<2	<2-3	<2-3	<2-3	2 to 5		<2-3	
Shape								
Bangladesh								
China		Short & thick		Short & thick			Long & thin	Short & thick
India	Long & thin	Short-thick-deep	Long & thin			Short-thick-deep	Long & thin	
Indonesia								
Thailand	Big, long & thin	Big, short & thick	Big, long & thin		Big, short-thick-deep			
Northern Viet Nam	Short & thick	Short-thick-deep	Short & thick	Short-thick-deep	Short & thick		Short/long & thick	
Southern Viet Nam	Short-thick-deep	Short & thick	Short/Long & thick	Short & thick	Short-thick-deep		Short/long & thick	
Colour								
Bangladesh								
China		Reddish & yellow		Silver			Black-Green-silver	Black and Silver
India								
Indonesia								
Thailand	Silver	Yellow/Silver	Silver		Silver			
Northern Viet Nam	Light	yellow	Black-blue	Silver	Light-blue		Light, Light-blue	
Southern Viet Nam	Bright	Yellow	Bright	Bright	Yellow fin		Bright	
Body Parts								
Bangladesh	Belly, Tail, Back		Belly, Tail, Back	Belly, Back, Head		Head, belly, back		
China								
India	Back, Belly, Tail	Belly, Back, Tail	Belly, Back, Egg			Belly, Back, Tail	Belly, Back, Tail	
Indonesia								
Thailand	Back, Belly, Egg	Back, Belly, Egg	Back, Egg, Belly		Back, Belly, Egg			
Northern Viet Nam	Head, Back, Belly	Back, Egg, Belly	Back, Tail, Head	Belly, Head, Back			Back, Belly, Tail	
Southern Viet Nam	Head, Belly, Egg	Head, Belly, Egg	Tail, Back, Head	Back, Belly, Head	Back, Belly, Egg		Tail, Belly, Back	

Table 19. Estimates of demand and income elasticities

Countries	Price elasticities of demand for fish	Income elasticity of demand for fish
Bangladesh	rohu (-1.13), catla (-0.75), mrigal and silver carp (-0.91), other exotic carp (-1.07), silver barb (-1.09), river shad (-0.91), assorted (-1.10), live (-0.98), high valued (-0.93). (this is from lower to higher income group): river shad (-1.05 to -0.88), live (-1.45 to -1.00), carps (-2.87 to -2.02), assorted small (-0.42 to -0.59), shrimp (-0.58 to -0.46), dried fish (-1.23 to -1.80)	Expenditure: 0.79, income: o.65 a. Expenditure: 0.96 to 1.10 for most species
China	-1.48 (using LA/AIDS model) -1.78 to -2.37 (using quadratic expenditure system)	Expenditure: 1.45 (country), 1.39 (rural area), 1.48 (urban area) d. Expenditure: 1.86 to 2.85 ; 0.9 to 1.1
India	e. -1.97 (rural), -0.913 (urban)	0.63 to 0.89 (rural area) 0.85 to 1.04 (urban area)
Philippines	b. -1.00 (tilapia), -1.2 (carps), -1.5 (crustaceans), -1.5 (high valued), 0.75 (low valued) -0.65 (tilapia), -0.63 (milk fish), -1.50 (tuna), -0.41 (round scad), -1.52 (prawn)	h. 0.43 to 1.20 (urban areas and different income classes) 0.57 to 1.61 (rural areas and different income classes)
Thailand	- 0.7 (silver barb), -0.9 (walking catfish), -0.9 (striped snake headed) b. -1.0 (tilapia), -1.10 (carps), -1.50 (crustaceans), -1.50 (high valued species), -0.50 (other low valued species)	Income: 0.8 to 4.1

SOURCES: (a) Provisional estimate of Alam and Kamruzzaman, 2000; (b) Dey *et al*., 2000a; (c) Alam Shamsul, 2000; (d) Olalo *et. al*., 2000; (e). Meenakshi and Ray, 1999; (f) Olalo, 2000; (g) Somying

Piumsombun, 2000; (h) Bhalla and Hazell, 1998.

Table 20. Fish market structure in selected Asian countries

Indicator	Bangladesh	China	India	Thailand	Philippines
Market competitiveness	Non-competitive More oligopolistic	Competitive Price increasing	Not competitive Demand, supply and price - all increasing	Competitive	Not competitive There is no transparency in the bidding process Oligopolistic type of market
Market channel	Relatively large and complex	na	Short	Long but complex	Short
Market intermediaries	3-4	na	3	4-5	4
Market infrastructure/facilities	Poor	Active govt. initiatives exist for investment in markets. New aquatic product markets being constructed	Poor	Fairly reasonable	Reasonably good
Market ownership	Private sector	Private sector	Private sector	Private sector & more organized	Private sector
Barrier to entry	Present	Absent	Present	Absent	Absent
Marketing margin and share of intermediaries	High. US$ 14.4-16.9 per quintal 56% share	na	Marketing margins 50-60% vary across seasons	51-76% Producer share 5-15% retailer share	US$ 0.15-0.43/kg
Producers bargaining power	Very low	Well	Low	Well	Well

NOTES: na = information not available

Source: Alam, 2000; Huang *et al.,* 2000; Bhatta, 2000; Piumsombun, 2000; Olalo, 2000.

Table 21. Other distinguishing indicators of fisheries of selected Asian countries

Indicator	Bangladesh	China	India	Thailand	Philippines
Production impact on price of fish	Price increasing	Supply and demand increased. Price also increased			Price increasing (for milkfish and tilapia) and decreasing for prawn
Purchasing power	Low	Moderate			
Price trend of fish and non-fish food	Increasing	Increasing	Increasing	Low for cultured species, but the trend is increasing	Declining (tilapia) Increasing (milkfish and prawn)
Gender in aquaculture and fish trade	Increasing for culture fisheries but not for marketing. More participation in NGO's programme		Increasing more in marketing	Male dominated in farming but female dominated in marketing	more in marketing-processing less in production
Access to credit	Low (high) for smaller (bigger) farms for public sector credit. Reverse for private source of credit. Public sector flow is decreasing.	na	Private sector including intermediaries: linked to production and marketing For aquaculture: public source exists.	Confined to mostly private intermediaries (for production and marketing), but bigger traders have access to public sector loan	Bulk of the marketing credit is provided by intermediaries and processors. Government credit is for guarantee cover, infrastructure and port services

SOURCE: FAO, 1996; Alam, 2000; Huang *et al.,* 2000; Bhatta, 2000; Piumsombun, 2000; Olalo, 2000;

NOTE: na = information not available

Figure 1. The dominant marketing channels (product route to ultimate consumers) of freshwater fish for domestic consumption in Bangladesh.

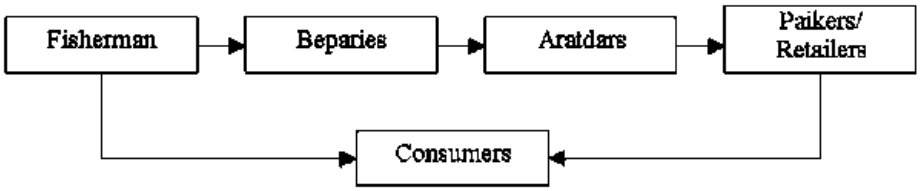


Figure 2. An investigation of the flow of fish channelled at every intermediary at an Upazila-level market in Bangladesh.

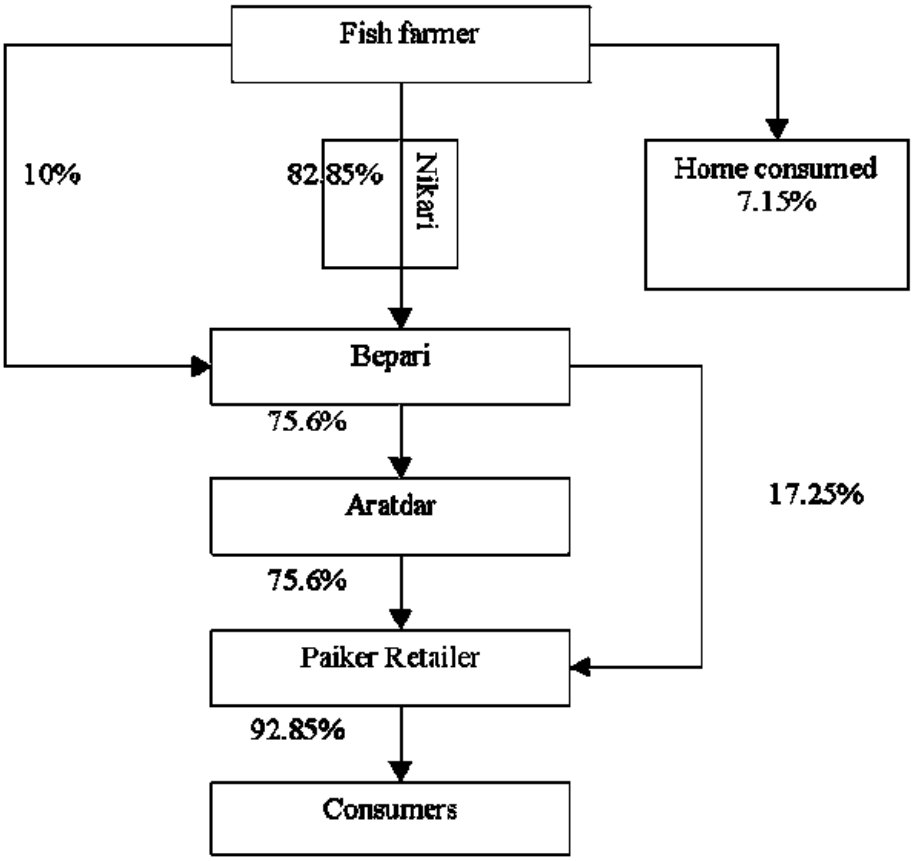


Figure 3. An emerging market channel for commercial pond fishery in Bangladesh.

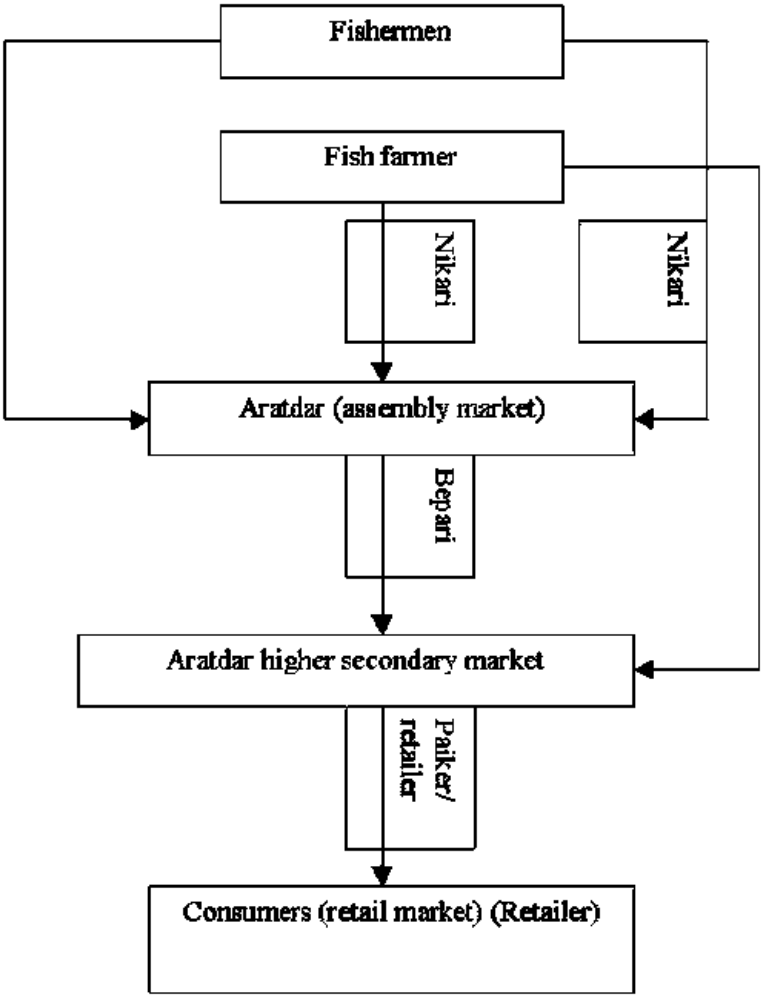
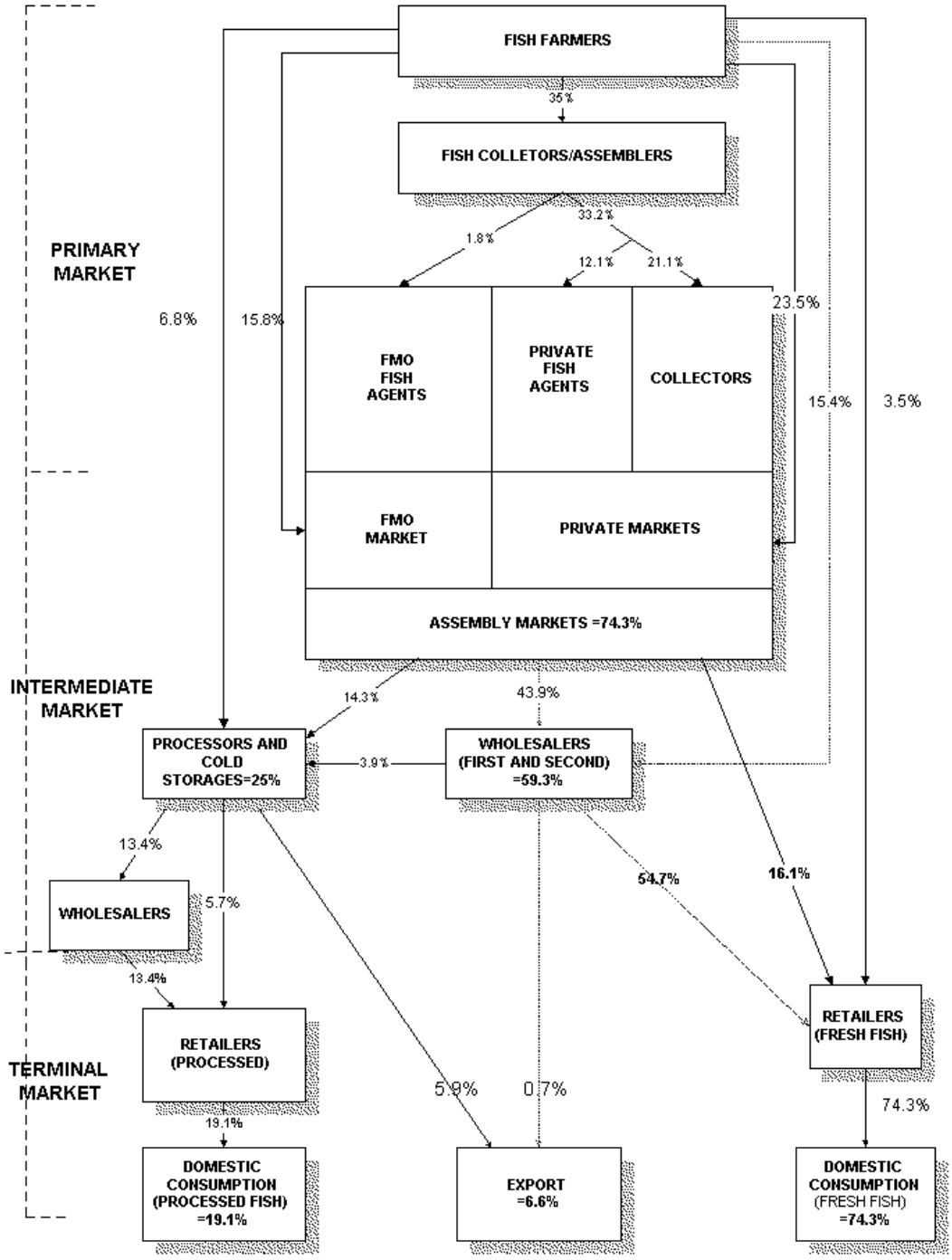


Figure 4. Marketing channel of cultured freshwater fish in Thailand.


FISH FARMERS
35%
FISH COLLETORS/ASSEMBLERS
33.2%
1.8%
12.1%
21.1%
PRIMARY MARKET
6.8%
15.8%
23.5%
FMO FISH AGENTS
PRIVATE FISH AGENTS
COLLECTORS
15.4%
3.5%
FMO MARKET
PRIVATE MARKETS
ASSEMBLY MARKETS =74.3%
INTERMEDIATE MARKET
14.3%
43.9%
PROCESSORS AND COLD STORAGES=25%
3.9%
WHOLESALERS (FIRST AND SECOND) =59.3%
13.4%
54.7%
16.1%
WHOLESALERS
5.7%
13.4%
RETAILERS (FRESH FISH)
TERMINAL MARKET
RETAILERS (PROCESSED)
5.9%
0.7%
74.3%
19.1%
DOMESTIC CONSUMPTION (PROCESSED FISH) =19.1%
EXPORT =6.6%
DOMESTIC CONSUMPTION (FRESH FISH) =74.3%