

1. INTRODUCTION

It is a truism that in general marketing aspects of aquaculture products, the total global value of which in 2005 was estimated at US\$78 383 259 900, have focused mainly on relatively high valued commodities such as shrimp and carnivorous diadromous (e.g. salmonids) and marine finfish (grouper, sea bass, etc.), and shellfish such as oyster, and even on relatively special market chains such as “live reef-fish” (Sadovy *et al.*, 2003; Sim, 2006; Johnston, 2007). From a production viewpoint, however, in 2005 all of the above commodities accounted for 17.3 percent (10 884 440 tonnes) only. The other cultured commodities that can be categorized as relatively non-high value are predominantly freshwater finfish. The latter production in Asia in 2005 was 24 419 668 tonnes valued at US\$24 758 370 800, as opposed to the total global production and value of 57 972 482 tonnes and US\$63 144 162 600 (FAO, 2007).

The current study was undertaken in view of the importance of the relatively non-high value cultured commodities, in aquaculture production and value, and its impacts on rural development, food security and contribution to poverty alleviation, and to contribute to the knowledge-gap in respect of marketing of such cultured commodities. The study attempts to cover selected aquaculture practices with the overall objective of evaluating and recognizing the potential areas for improvement in marketing and product development. In view of the fact that finfish accounts mostly for the relatively not so high valued cultured products, particularly in the Asian context, the main emphasis in the study is on finfish. Admittedly, the term non-high value cultured commodities is not explicitly definable. A commodity that is high valued or preferred in one region may not be so elsewhere. However, for purposes of this study non-high value commodities are considered to be those that on average command a farmgate price of less than US\$3 per kilogram.

The study focused on selected Asian countries and differing aquaculture systems. Although tilapia farming is an important activity in Asia, and a commodity that is relatively less high value, the associated market chains were not dealt with in this study. Market chains in respect of tilapias had been dealt with in detail in the recent past, perhaps primarily driven by the fact that it is exported in significant quantities to the United States of America (Josupeit, 2005, 2007), and has attracted much attention, public and scientific, on many aspects of its aquaculture (De Silva *et al.*, 2004; Gupta and Acosta, 2004a, 2004b). In addition, the study also dealt with other commodities, albeit to a lesser degree, in particular on commodities on which some aquaculture systems are dependent, such as in the case of trash fish/low value fish as feed sources for small-scale marine finfish farming. The data, apart from the production statistics (FAO, 2007), have been collated through specific surveys carried out in each country. However, prior to dwelling into the market chains *per se* it is pertinent to consider a few related aspects that impact upon the former.

1.1 Importance of relatively non-high value cultured commodities in aquaculture

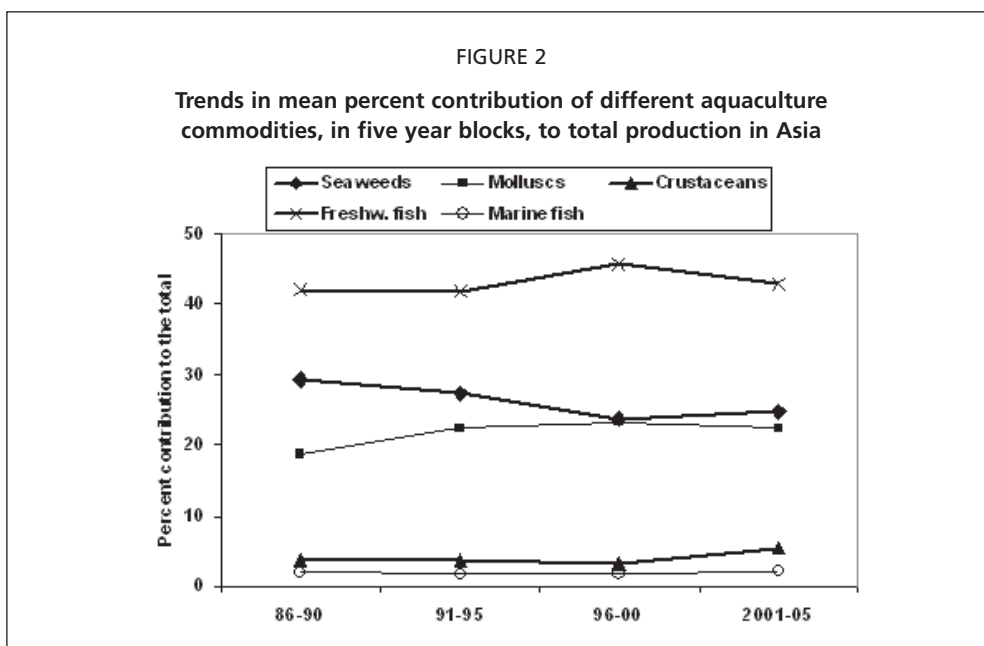
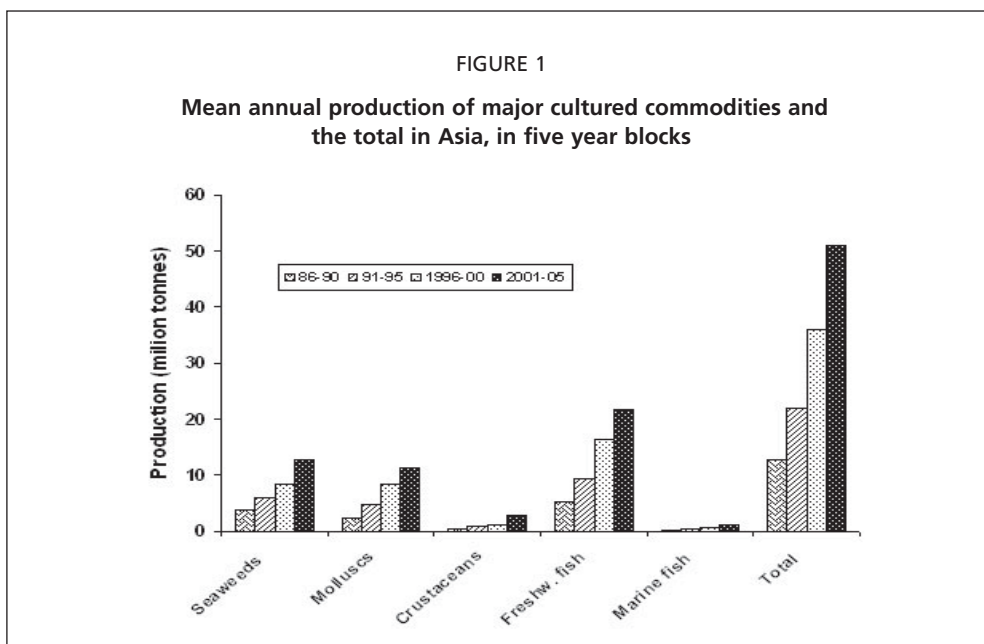
In most of the countries under consideration in this study, the contribution of aquaculture to the GDP has bypassed that from the capture fisheries (Table 1); the great bulk of this production being of relatively non-high value species. It is therefore appropriate to consider in detail the importance of these species in aquaculture in Asia, from an overall perspective and commodity group-wise.

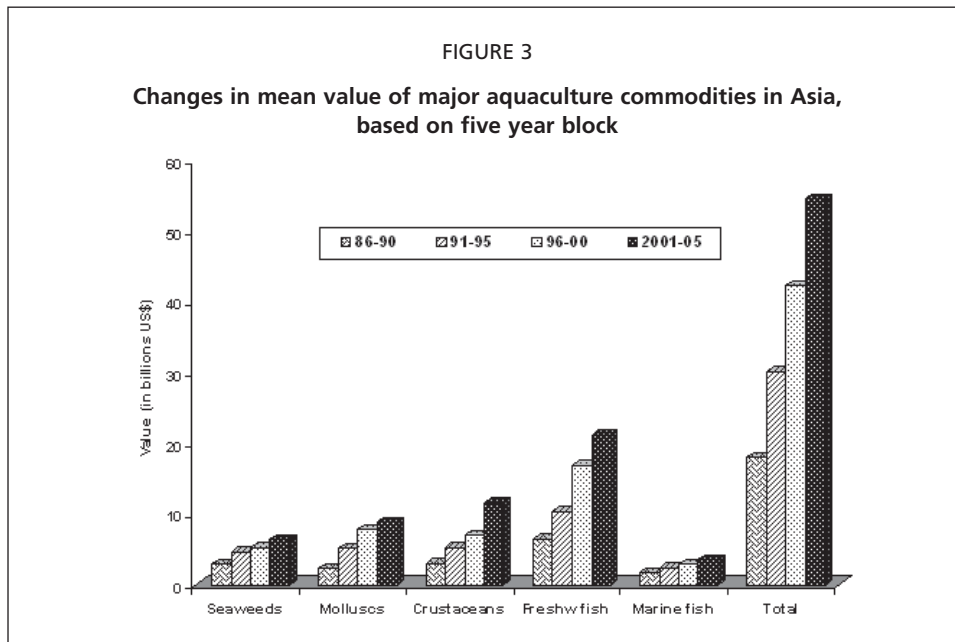
TABLE 1
Production value as percent of GDP

| | Capture fisheries | Aquaculture |
|----------------------------------|-------------------|-------------|
| China | 1.132 | 2.618 |
| Lao People's Democratic Republic | 1.432 | 5.775 |
| Myanmar | na | 0.167 |
| Thailand | 2.044 | 2.071 |
| Viet Nam | 3.702 | 3.497 |

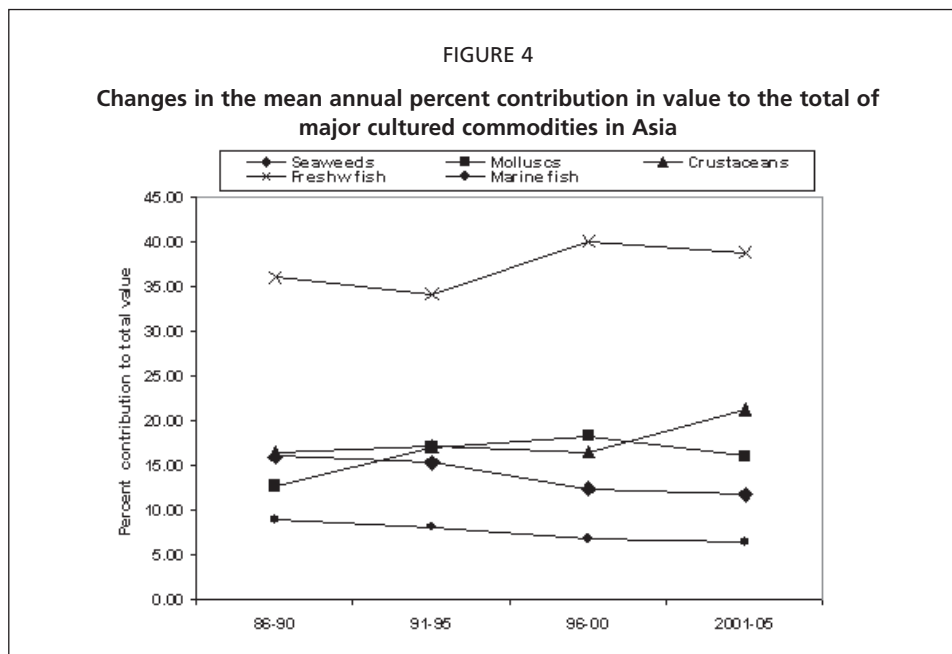
Source: modified after Sugiyama, Staples and Funge-Smith, 2004.

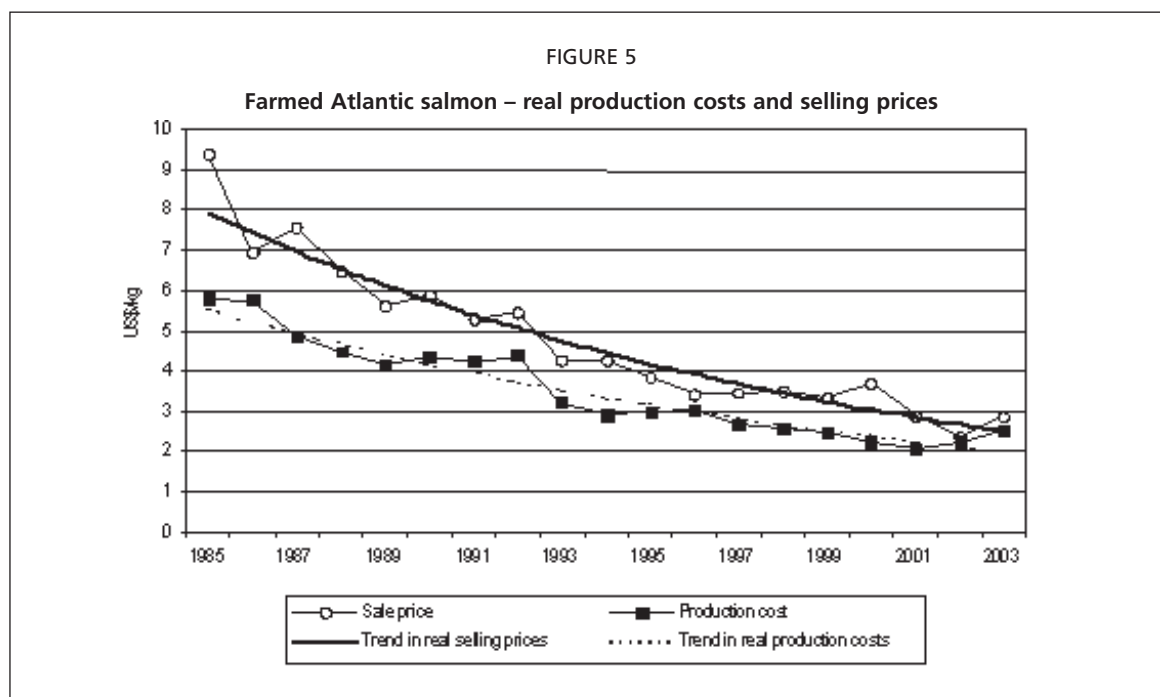
Total Asian aquaculture production in 2005 was 50 984 852 tonnes (FAO, 2007) and has been steadily increasing, in respect of all commodities over the past two decades or more (Figure 1). On the other hand, the mean proportionate contribution (Figure 2) of the different commodity groups has remained almost static and/or declined, apart from shrimp. Through the years freshwater finfish have contributed the most to overall aquaculture production in Asia, currently accounting for nearly 42.8 percent of the total (Figure 2). Comparable trends are reflected in the value of the other commodities (Figures 3 and 4), and the most disconcerting trend is seen in marine finfish, normally regarded to be a relatively high valued commodity. The mean market value of marine finfish showed a significant decline over the years. Overall, in value, too, freshwater finfish contributes highest to Asian aquaculture, around 40 percent at present (Figure 4). In general, the gradual reduction in value is common to almost all cultured commodities, barring some which may be specifically affected in certain instances by world calamities, such as the incidence of severe acute respiratory syndrome (SARS), terrorist events and the like (Sim, 2007). Overall, the





farming of aquatic commodities progressed almost unabated, and this has become possible only because the production techniques and management have improved over the years, and consequently the cost of production of a unit weight has decreased, thereby keeping the farming activities viable. This is best exemplified in the case of salmonid farming, which has been studied in greater detail (Figure 5), and it is most likely that the same trends have been occurring in respect of other commodities; comparable studies on other commodities are urgently warranted in order to better plan further developments progressed almost unabated, and this has become possible only because the production techniques and management have improved over the years, and consequently the cost of production of a unit weight has decreased, thereby keeping the farming activities viable. This is best exemplified in the case of salmonid farming, which has been studied in greater detail (Figure 5), and it is most likely that the same trends have been occurring in respect of other commodities; comparable studies on other commodities are urgently warranted in order to better plan further developments and product improvements, as well as to ensure that the producers and consumers





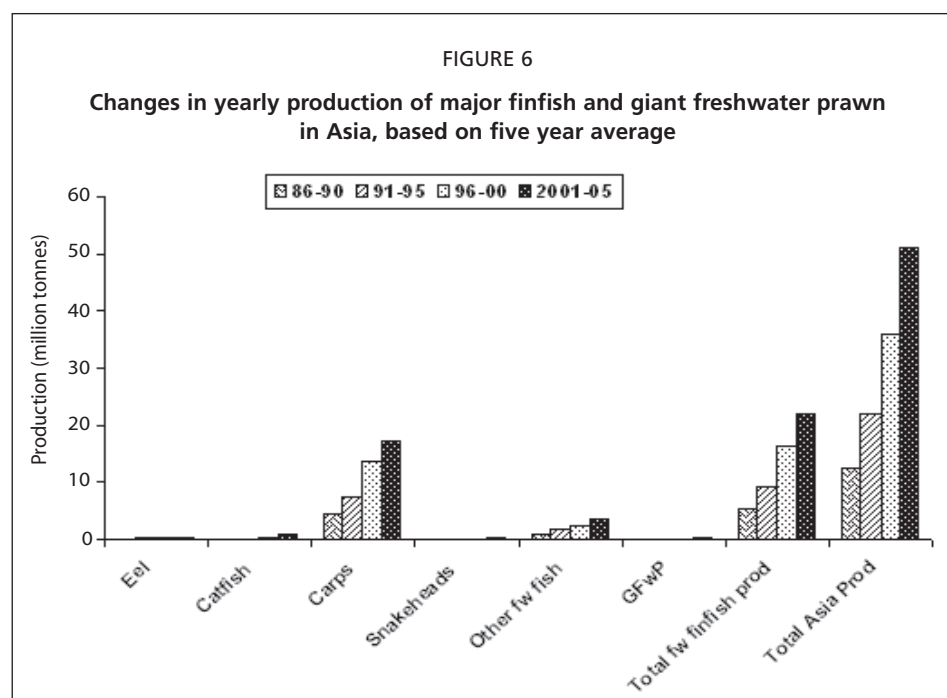
Source: MLC International Ltd

in the value chain are appropriately benefited. In Asian aquaculture, of the cultured freshwater finfish (also includes the giant freshwater prawn), which is the most dominant in both production total and value, essentially consists of four species groups: the freshwater eels (family Anguillidae), catfishes (families Pangasidae, Siluridae, Claridae), carps (family Cyprinidae) and snakeheads (family Ophicephalidae, Channidae) and all other species/groups put together into one group (Figure 6). The latter is unavoidable as the statistical returns from some countries do not separate the species groups. For example, it is reputed that *Pangasius* catfish culture in the Mekong Delta in southern Viet Nam accounts for a production of about 450 000 tonnes in 2004 (Le, Truc and Huy, 2007), and current production of nearly one million tonnes, but is reported as freshwater fish, not as catfish. Eels, on the other hand, cannot be considered as a relatively low value species, and its culture is restricted to a few countries in Asia, and also differs from all other groups in that it is based on wild caught seed stocks. All in all, among the cultured freshwater finfish, carps are the major contributor to the total production (Figure 7). On the basis of the above information it is most pertinent that this study lays major emphasis on carp culture and the related marketing chains.

1.2 Trends in fish consumption in the countries studied

Marketing of any commodity is closely linked, and indeed driven by the consumption patterns, and fish is no exception to this general rule. Asia is known to have a significantly higher per capita fish consumption rate, estimated at 27 kg per capita per year, as compared to the world average of 18, based on 2 000 values (Dey and Garcia, 2007).

Estimates available for individual countries, however, could differ, marginally between sources (Table 2). These differences could arise from the databases used in the computations, and the years under consideration. Although the average fish consumption patterns are a useful index for planning fishery related development activities as well as for assessing the nutritional status, it is insufficiently detailed to evaluate the corresponding market chains and developments thereof. Unfortunately information on details on the household budgetary expenditure, type of fish consumed and preferences thereof and the like is rather scanty. Some of the salient points of the study by Dey and Garcia (2007), which are relevant here are summarized in Table 3.



It is evident from Table 3 that the percent share of the food basket spent on fish varies significantly between countries, and most revealing is that in all four countries considered presently freshwater finfish – the commodity that contributes most to global and Asian aquaculture production – accounts for the biggest share; the highest percent share was in Viet Nam where freshwater finfish accounted for 68 percent of all fish consumed. As expected, the amount spent on each of the commodities was significantly lower in the case of freshwater finfish as compared to shellfish and/or marine finfish. Overall, one wonders whether the trend on the greater importance of finfish in the food basket reflects (a) a production trend and/or (b) an affordability trend and/or (c) a combination of both, and (d) as well as availability in a fresher state, particularly in remote rural areas where most production occurs. These are some of the issues that need to be addressed if the market chains are to be developed and improved upon resulting in benefits to both the producer and the consumer.

TABLE 2

Mean fish consumption rates (kg per capita per year) of the countries dealt with in this study

| Country | Source 1 | Source 2 |
|----------------------------------|----------|----------|
| China | 25.0 | 35.7 |
| India | 5.6 | 7.1 |
| Lao People's Democratic Republic | na | 16.3 |
| Myanmar | na | 18.9 |
| Thailand | 32.7 | 40.0 |
| Viet Nam | 14.0 | 22.8 |

Source 1: Dey and Garcia, 2007; Source 2: Speedy, 2003.

1.3 TRENDS IN OVERALL MARKET VALUE OF CULTURED FRESHWATER SPECIES

Although cultured freshwater finfish species literally constitute the backbone of global aquaculture, over the years the market price commanded by these species has declined markedly over a 20 year period, most notably for snakehead, followed by eels, which is considered a relatively high valued species (Table 4). This mean decline in price of the different groups is not necessarily related to an increase in production, and hence availability, as for example the production of eels and snakehead has remained almost static over the years. The yearly changes in the market value of the species groups referred to here are shown in

TABLE 3
Percent share of food budget spent on fish, types of fish that is spent on and average price in US\$ of selected countries

| Country | Share(%) | Percent share of fish | | | | Mean amount spent (US\$) | | | |
|----------|----------|-----------------------|------|--------|----------|--------------------------|------|--------|----------|
| | | FW | Mar. | Others | Process. | FW | Mar. | Others | Process. |
| China | 5 | 40 | 35 | 13 | – | 1.02 | 1.75 | 2.85 | – |
| India | 6 | 62 | 29 | 5 | – | 0.59 | 0.40 | 1.23 | – |
| Thailand | 16 | 43 | 21 | 9 | 9 | 0.71 | 0.86 | 3.58 | 0.63 |
| VietNam | 19 | 68 | 27 | 2 | 3 | 1.03 | 1.47 | 6.30 | 2.10 |

Source: compiled from data in (Dey and Garcia, 2007).

Notes: FW: freshwater finfish; Marine: marine finfish; Others: shrimp etc.; Process.: processed fish

Figure 8. In almost all instances there had been a decline in the market value. Declines in market values of cultured finfish elsewhere has also been reported, such as for example that of European sea bass and gilthead bream in the Mediterranean countries, Italy, Greece and Turkey, where over a five-year period a decline of about 30 percent was reported (Cardia and Lovatelli, 2007). However, this decline was attributed to an increase in production and thereby reduced production costs, leading not only to sharply lower prices but also improved availability for consumers. On the other hand, in individual countries there had been a slight increase in the price, albeit small, of cultured species groups.

TABLE 4
Changes in the mean value per tonne of selected cultured freshwater fish and percentage mean change over the 20 year period

| Species group | Value per tonne (thousand US\$/tonne) | % change | | | |
|---------------|--|----------|---------|---------|------------------|
| | 86–90 | 91–95 | 96–2000 | 2001–05 | 86–90 to 2001–05 |
| Carps | 1.172 | 1.082 | 0.971 | 0.883 | 24.6 |
| Catfish | 1.551 | 1.273 | 1.252 | 1.112 | 28.3 |
| Eel | 7.792 | 6.413 | 4.339 | 3.680 | 52.8 |
| Snakeheads | 4.663 | 5.855 | 1.068 | 0.860 | 81.6 |
| GFwP | 4.705 | 6.246 | 3.972 | 3.742 | 20.5 |

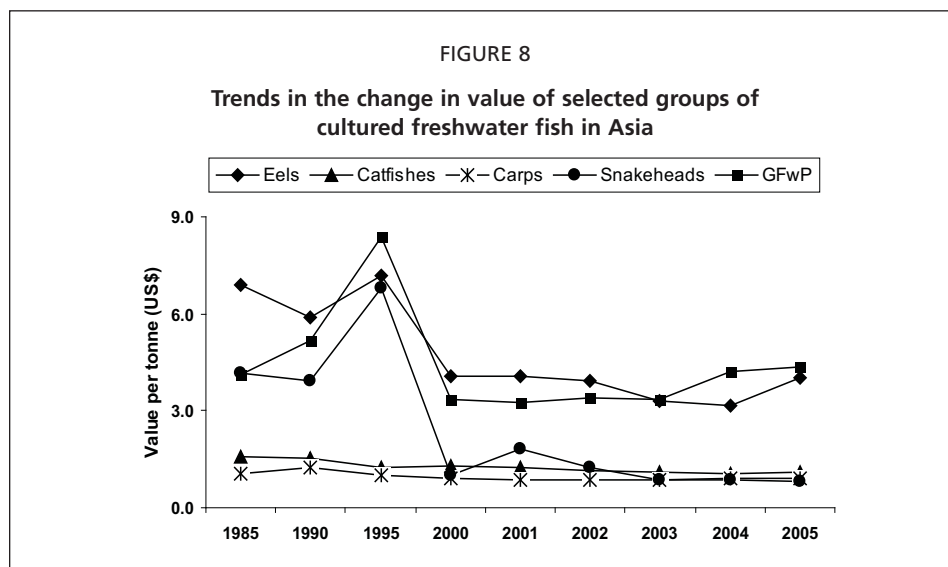
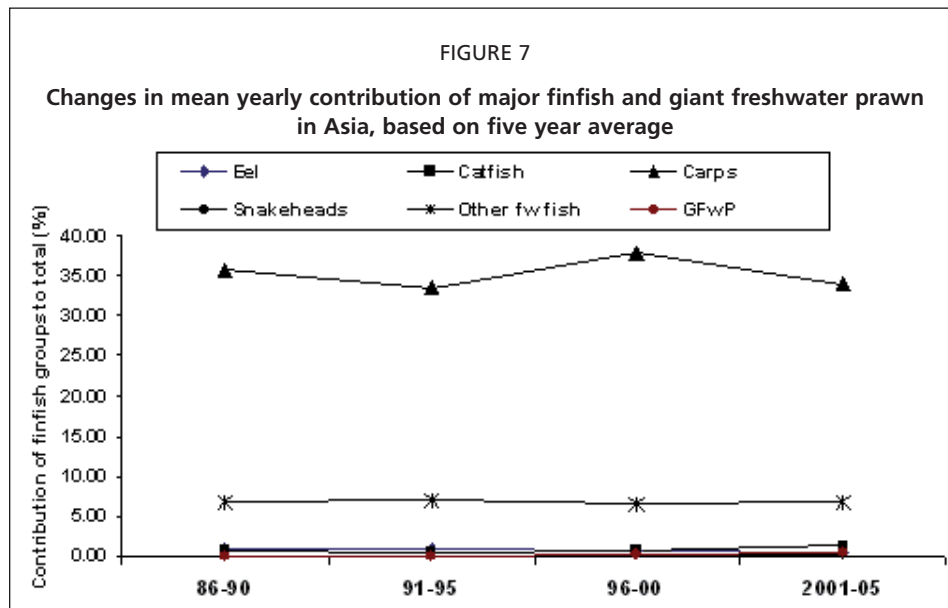
2. CARP CULTURE

The data suggest that carps, which are generally dominated by the Chinese and Indian major carps, contribute nearly 40 percent of total Asian finfish production (Figure 7). On the other hand, when finfish only are considered, in Asian aquaculture the overall dominance of carps is further exemplified, currently accounting for nearly 80 percent of the production (Figure 9). In value, the yearly production of carps accounted for approximately US\$15 billion in the period 2000 to 2005, or for nearly 90 percent of all finfish (plus giant freshwater prawn) production in Asia (Figure 10).

2.1 Major carp species cultured

The main carp species cultured in Asia can be broadly divided into three groups: two groups of major carps, the Chinese and Indian major carps, represented by grass carp, *Ctenopharyngodon idellus*, silver carp, *Hypophthalmichthys molitrix*, bighead carp, *Aristichthys nobilis* and mud carp, *Cirrhinus molitotrella*, and rohu, *Labeo rohita*, catla, *Catla catla* and mrigal, *Cirrhinus mrigal*, respectively; and the third being common carp, *Cyprinus carpio*, which strictly is alien to Asia proper (Balon, 2004). The Chinese and Indian major carps grow to a relatively large size, some of the former up to 20 to 25 kg. However, cultured fish are generally marketed at a size of 1 to 5 kg, being variable from country to country and practice to practice.

In general the great bulk of carp culture is conducted in earthen ponds, at times integrated with animal husbandry, particularly in PR China, but cage culture and culture-based fisheries of these species is not uncommon. Equally, in many Asian countries many of the major carp species and



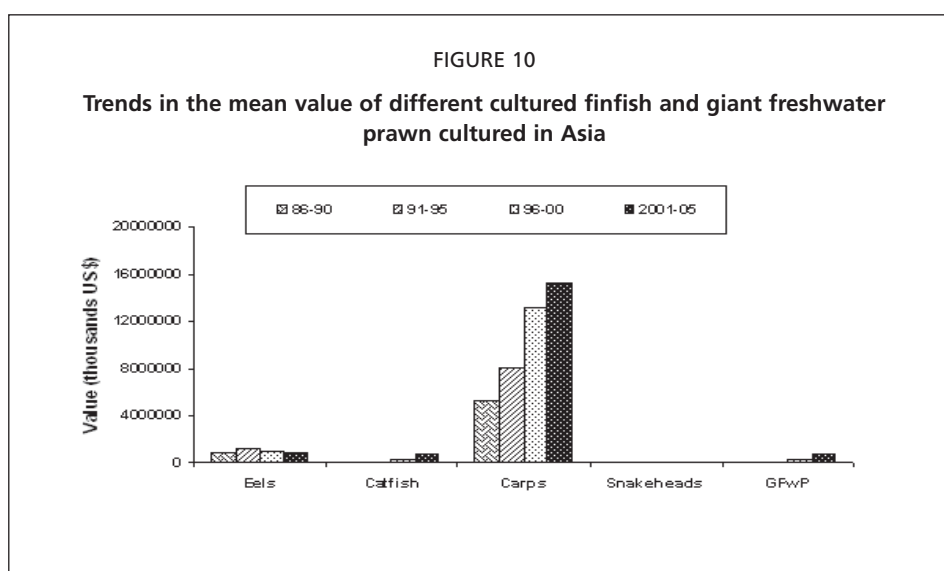
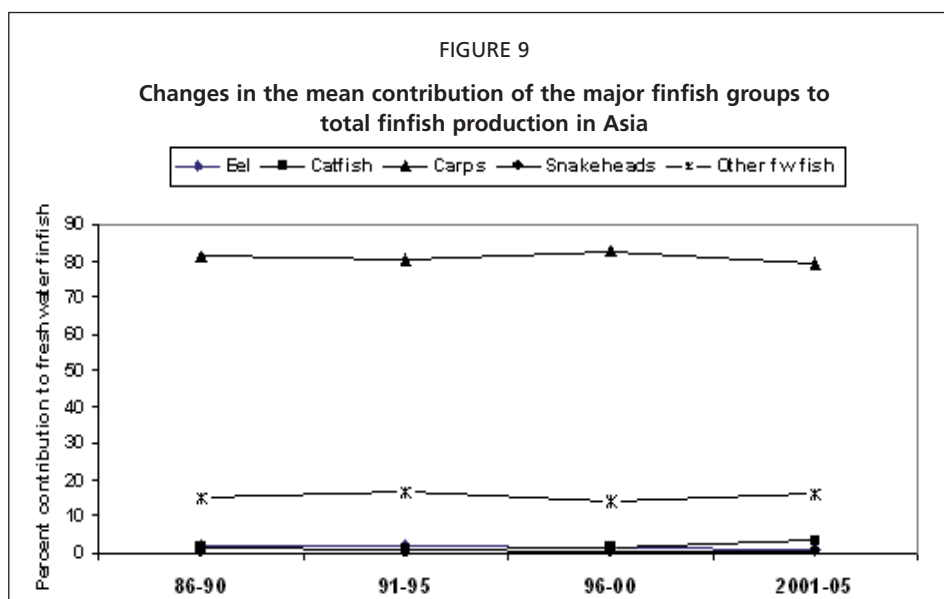
common carp are also used for stock enhancement programs of large lakes and reservoirs. Chinese and Indian major carps, as well as common carp, have been translocated across the globe and are major contributors to extensive and semi-intensive culture practices in Asia (De Silva *et al.*, 2006).

2.2 Case studies

2.2.1 India

India is the second largest aquaculture producer in the world. The backbone of Indian aquaculture is inland, and is based primarily on the Indian major carp species, supplemented by others (Figure 11). It has recently been demonstrated (De Silva *et al.*, 2006) that Indian aquaculture still is dominated by carp (Indian major carps) culture, which in volume accounts for around 80 percent of the total cultured production (Figure 12).

Of the carps the Indian major carps accounted for 66 percent, common carp and Chinese major carps for 21 and 12.6 percent, respectively. Overall, in 2005 the aquaculture produce valued US\$3.730 billion, amounting to US\$1 291 per tonne or US\$1.29 per kilogram. When compared to the 1995 figures (production 1 658 807 tonnes, valued at US\$1.946 billion), the price increase has been very marginal; US\$1 173 per tonne (US\$1.17 per kilogram). The proportionate contribution of different



commodities to the total cultured production in India in 2005 is shown in Figure 12. It is evident that although carps accounted for 89 percent of the production, in value accounted for only up to 76 percent whereas shrimp in value was 18 percent of the total but in volume was only 4.5 percent. All in all it is evident that carp culture in India, both in production volume and in value, is the most predominant aquaculture commodity.

Carp culture, bulk of which is conducted in earthen ponds, practised extensively and semi-intensively, is widespread in India in most of the states. However, the leading state of carp culture in India is the southeastern state of Andhra Pradesh. Much has been written on carp culture in India (Jhingran, 1991), and in particular in respect of that in Kolleru Lake area in Andhra Pradesh, which witnessed adoption of new culture practices and an explosive growth in production beginning in the early 1980s (Veerina *et al.*, 1999; Nandeesh, 2006).

Carp farming and associated marketing chains of carp cultured in Kolleru Lake area, India ***Kolleru Lake***

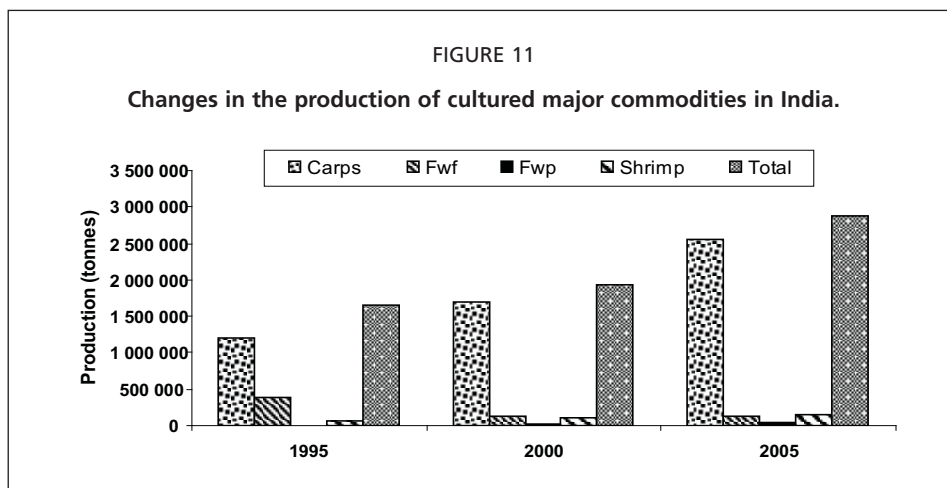
Kolleru Lake is a large freshwater lake in India's Andhra Pradesh state, located between the deltas of the Krishna and Godavari rivers, of Krishna and West Godavari districts. The lake serves

as a natural flood-balancing reservoir for the two rivers. The lake is fed directly by the seasonal Budameru and Tammileru rivers, and is connected to the Krishna and Godavari systems by over 68 inflowing drains and channels (http://en.wikipedia.org/wiki/Kolleru_Lake).

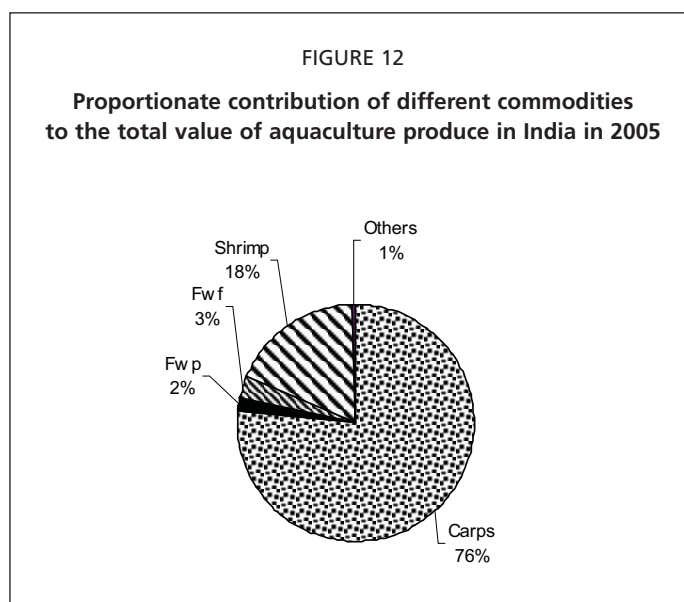
The aquaculture developments in Kolleru Lake have been a contentious issue over the last decade, because of reclamation of the lake area for pond construction for carp farming. Jayanthi *et al.* (2006) estimated that between 1967 and 2004 the lake area was reduced to 3.7 percent of the original 180.4 km², and that what was left as the lake was in a degradable state. The authors also noted that aquaculture developments accounted for 99.7 km², representing 55.3 percent of the original area. As a consequence to increased impetus on environmental protection (Kolleru Lake is a prescribed RAMSAR Wetland Site) the State Government commenced reclaiming unauthorized aquaculture ponds, and currently the area under carp farming in Kolleru is approximately 50 520 ha.

Farming practices

In carp farming in Kolleru Lake area “composite fish culture” principle is adopted (Jhingran, 1991). Mainly two Indian major carp species (rohu and catla) are stocked as yearlings of approximately 100 g in weight, and the ponds are limed and fertilized. The feed used is a supplementary feed



Note: Fwf – freshwater fish species other than carps; Fwp – freshwater prawns



of which the main ingredients are de-oiled rice barn, groundnut oil cake and cottonseed cake at the rate of about 20 000 kg/ ha/ yr. The fish are harvested after 6 to 8 months at a size of about 1 kg (rohu) and 2 kg (catla), and the overall mean production is about 8 000 to 10 000 kg/ha/yr (Nandeesh, 2006).

Modern static pond fish culture in Kolleru area was initiated by the State Government in 1978 by forming fishermen cooperative societies and by encouraging construction of 133 fish ponds in an area of 290 ha benefiting 6 711 fishers. The land leases for pond construction were of three categories: cooperatives (20 percent), village ponds (28 percent) and private land (52 percent).

In general, a three-tier (nursery, rearing and grow-out) culture pond system is practised. In nursery ponds three-day-old spawn is grown up to 25 mm (fingerling). Nursery ponds range in size from 0.04 to 0.08 ha. Nursery farms are usually managed by commercial seed producers. This trade has become a specialized business to the entire village of Bhujabalapatnam, for example, and is capable of meeting all the seed requirements in the region.

Young fingerlings (25 mm) are stocked in rearing ponds at a density of 50 000–100 000 per hectare, and these farms also maintain grow-out ponds wherein fish are raised to market size, while in rearing ponds fingerlings are stocked for future use after the harvest of the standing crop. The rearing period varies from 8 to 15 months during which the fry grows to a weight of about 50–100 g with a survival of 70–80 percent. Such “stunted” yearlings form the base for the grow-out phase.

By using stunted yearlings in culture ponds:

- rearing cost during the initial slow growth period is reduced;
- stunted yearlings pick up growth in grow-out ponds, compensating for the former;
- results in nearly 70–80 percent survival in grow-out ponds.

Marketing chain(s)

It has been said that there is practically no definite structure of fish markets in India (Pandey and Chaturvedi, 1984) and that fish marketing in India, Bangladesh, Thailand and the Philippines is largely controlled by the private sector (Dey, Paraguas and Alam, 2001). However, in respect of the Kolleru Carp Farming Systems the market chains have evolved over the years and have gained stability. Equally, improved materials are used in packing, and transportation techniques have ensured that fish reach the consumers in a relatively fresh state, and consequently have been able to maintain stable prices to the benefit of all parties in the value chain. Indeed, Sahoo *et al.* (2001) observed that the existence of proper marketing channels has brought improved incomes to the producers that have helped in the establishment and expansion of carp culture in Kolleru area. The produce from Kolleru Carp Farming Systems is primarily exported to many states in India and is available fresh chilled to the consumer (Table 5).

Harvesting

Stock is harvested by partial draining of the ponds and seining. In some cases, the ponds are drained completely and the fish trapped in the trench areas are collected using a drag net. About 20–30 percent of the farmers conduct a partial harvest when standing biomass exceeds 6–8 t ha⁻¹, after a grow-out period of 6–8 months, and the remaining fish are continued to grow for another 2–3 months before the second and final harvest. During the final harvest, once the process starts, the fish may not be marketed all in one day, and the procedure may continue for 5–15 days depending on the pond size, fish biomass, market demand, price fluctuations, natural calamities resulting in road blocks for trucks to reach markets, etc.

Packing

While harvesting is in progress, arrangements are made on the farm sites for grading species size-wise. If there is no road access for the trucks to reach the pond site, tractors or boats are engaged to

TABLE 5
Details on the exports of Indian major carps produced in the Kolleru Carp Farming Systems throughout India

| State | Number of local markets | Important local markets | Quantity | | | |
|-------------------|-------------------------|----------------------------|-------------|------------|--------------|-------------|
| | | | Truck-loads | tonnes/day | tonnes/month | tonnes/year |
| West Bengal | 17 | Howrah, Siliguri | 105 | 525 | 15 750 | 1 89 000 |
| Assam | 10 | Gowhati, Jorhat | 28 | 140 | 4 200 | 50 400 |
| Jarkhand | 14 | Dhanbad | 24 | 120 | 3 600 | 43 200 |
| Bihhar | 5 | Patna, Muzaparpur | 19 | 95 | 2 850 | 34 200 |
| Maharashtra | 11 | Mumbai, Nagapur | 18 | 90 | 2 700 | 32 400 |
| Orissa | 6 | Cuttack, Bhadrak Jajpur | 10 | 50 | 1 500 | 18 000 |
| Uttar Pradesh | 8 | Gorakhpur, Lucknow | 9 | 45 | 1 350 | 16 200 |
| Madhya Pradesh | 5 | Jabalpur | 6 | 30 | 900 | 10 800 |
| Gujarat | 5 | Surat | 6 | 30 | 900 | 10 800 |
| Delhi | 1 | Delhi | 5 | 25 | 750 | 9 000 |
| Chattisgadh | 6 | Raipur, Durg | 4 | 20 | 600 | 7 200 |
| Tripura | 1 | Agartala | 3 | 15 | 450 | 5 400 |
| Nagaland | 2 | Dimnapur, Kohima | 2 | 10 | 300 | 3 600 |
| Rajastan | 1 | Jaipur | 2 | 10 | 300 | 3 600 |
| Manipur | 1 | Imphal | 1 | 5 | 150 | 1 800 |
| Arunachal Pradesh | 1 | Itanagar | 1 | 5 | 150 | 1 800 |
| Uttaranchal | 1 | Kitchchar | 1 | 5 | 150 | 1 800 |
| Kerala | 2 | Trichur, Alwae | 0.5 | 2.5 | 75 | 900 |
| Tamilnadu | 1 | Coimbattoor | 0.5 | 2.5 | 75 | 900 |

Source: from Dr Hari Babu, personal communication

carry fish from the pond to a nearby place where the trader's truck is parked. Semi-skilled labour in groups of 20–30, commonly referred to as “packers” conduct all these activities.

Transportation to markets

The produce from the Kolleru Carp Farming Systems is transported long distances, and only a small proportion is consumed locally (Table 5; Figure 13). Since the 1980s, methods of transportation of major carps from the Kolleru area have been made economically viable. The improved packing (coal material and insulated with rice husk pack) and insulation (thermo coal sheets are laid on the bottom and then crates are loaded) have made it possible to prevent the ice melting for up to 5 to 6 days, thereby increasing the shelf-life of the fish considerably.

On an average, 60–70 truckloads of fish per day are exported from Kolleru Carp Farming Systems (about 600 t of fish per day) of which approximately 25 trucks are for Howrah (Kolkata) market; 25 to Bihar region; about 10 trucks are for Siliguri region; and another 6–10 trucks are dispatched to Hyderabad, Maharastra, Kochi, Delhi and other places.

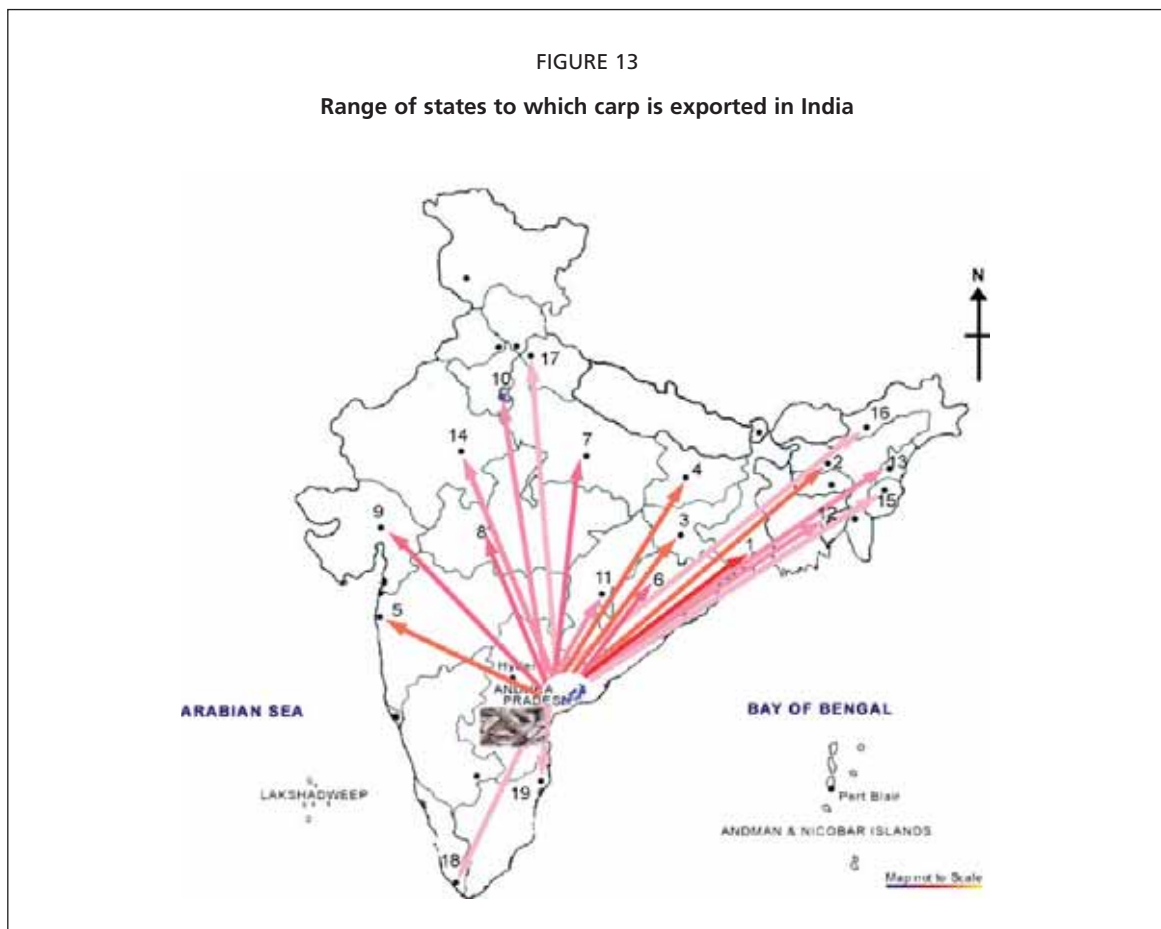
Markets and associated chains

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 the other state. Almost 100 percent of fish that is produced in Andhra Pradesh state in general and Kolleru area in particular are exported to Howrah (Kolkata), Bihar, Gauhati and other northeastern states of India. Among the Indian major carps, rohu is the most expensive, while mrigal is the cheapest in the consumer markets. The major marketing chains operating for Kolleru Carp Farming Systems produce are summarized schematically in Figure 14. The traditional and dependable market for Kolleru area cultured fish is Howrah, a market organized entirely by the private sector during the early days of establishing market channels for Kolleru area carps, when farmers were exporting the fish by themselves.

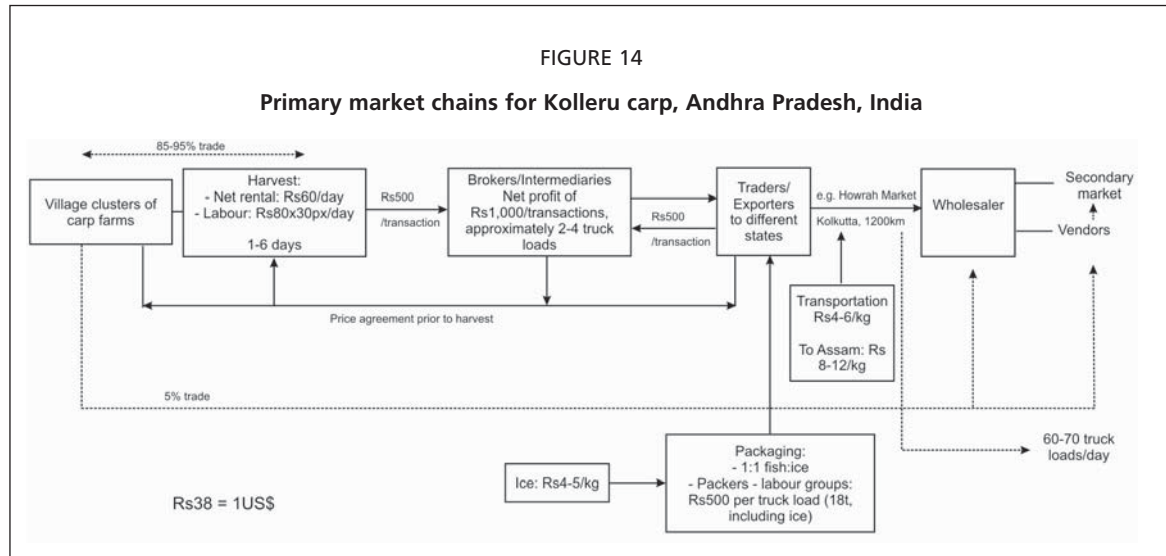
Recently, the majority of the farmers sell the produce at pond site through traders. In the Kolleru area, Eluru, Kaikaluru, Akiveedu, Bhimavaram and Ganaparam have been the major centres of fish trading, packing and export activity. All these places taken together involve about 50 traders or trading farms. Almost all these traders have their own infrastructure, i.e. offices, ice factories, plastic crates, graders, packers and packing sheds. The majority of these do not have trucks of their own but engage them on hire. There is one registered body, the Andhra Pradesh Fish Traders and Packers Association (Regd. No. 207/2000), with administrative offices located in Bhimavaram, West Godavari District. About 20 traders are reported to be members of this association. In addition to major traders, small-scale traders (60–65 members) who are all local, and 2–3 traders who belong to the Howrah market, also purchase fish from Kolleru carp farmers.

Fish on arrival at Howrah market is taken care of by “Aratdars” who are licensed traders at the marketplace. Prices on a daily basis are organized by these Aratdars on their own initiative. Bargaining of price in terms of eye estimation is followed, and ultimately Aratdars play a key role in unloading the fish on arrival from packed trucks. Aratdars pay a market cess (tax) of Rs. 500 per truck.

From major market points (fish assembly points) fish are moved to secondary markets that act as wholesale points for packers or retailers or vendors. Packers or vendors sell fish directly to consumers through different types of vending, including head loads/tricycles (rickshaw). Fish farmers do not sell fish directly, neither to the consumers in marketplace nor to the packers directly because of resistance from the Aratdars’ association.



Source: courtesy of Dr Hari Babu



Marketing of Kolleru carp in other states could be simpler. For example Aurangabad City (Maharashtra state): on average 2–3 truckloads of fish reach places such as Aurangabad, Mumbai and other places in Maharashtra state. Aurangabad is well connected by road as well as rail with Hyderabad in Andhra Pradesh (A.P.). The marketing channels could be any of the following:

- (I) Producer (A.P.) (distant) → primary wholesaler (distant) → wholesaler retailer/vendor → consumer.
- (II) Producer (A.P.) (distant) → primary wholesaler (distant) → secondary wholesaler (out station) → wholesaler → retailer → consumer.
- (III) Private pond owner (A.P.) (distant) → wholesaler → retailer → consumer.

The fish produced in places such as Kolleru area is procured from Channels I–III and are packed in ice and brought by the wholesalers from distant primary markets by road. The fish also comes by train through Channel I where the local wholesalers place an order via telephone and the distant seller undertakes the parcelling of the required fish in accordance with the order. The retailers purchase this fish and sell directly to consumers in local markets (Balaraj and Sonawane, 2001). There are four major fish merchants in the city controlling the fish wholesaling. As there is no established wholesale market, sales generally take place in open air at or near wholesaler's shop or house.

2.2.2 Myanmar

Fish is the main source of animal protein in Myanmar, with an estimated 41 kg per capita per annum consumption, one of the highest in the world (Ko Lay, 2006). Myanmar is considered an emerging “aquaculture” nation, with its relatively vast fresh and brackish water and marine resources (FAO and NACA, 2003). Aquaculture was also recognized as the fastest growing food production sector in Myanmar, registering a growth rate of over 40 percent for a decade since 1988, as opposed to only 5 percent in capture fisheries (Win, 2004). Aquaculture contributed approximately 21.8 percent to the fishery sector (2.56 million tonnes) in 2005–2006, of which 271 070 tonnes were exported, valued at US\$359.2 million (Ko Lay, 2006).

Currently the total aquaculture production is 474 510 tonnes with a mean production of 287 653 tonnes per year over the last five years (FAO, 2007), and the latter has registered significant growth over the years (Figure 15). The cultured carp production in 2005 was 165 000 tonnes, out of a total of 474 000 tonnes (FAO, 2007).

Aquaculture in Myanmar is almost totally inland, with carps (Indian major carps) followed by a few other freshwater species (Aye *et al.*, 2007) dominating production (e.g. catfish, tilapia). There also had been an upsurge in giant freshwater prawn culture in the last five years climbing from zero

to 50 tonnes in 2005 (FAO, 2007). Most importantly in some regions, carp culture – in particular rohu – has made major strides and has become a major export income earner for Myanmar, with a targeted value of US\$200 million in 2007 (Aye *et al.*, 2007).

Carp culture

Carps, predominantly rohu (*L. rohita*), catla (*C. catla*), mrigal (*C. mrigal*), common carp (*C. carpio*) and Java barb (*Puntius gonionotus*), and the exotic tilapia (*Oreochromis niloticus*) are commonly cultured in earthen ponds, of up to 1.0 to 3.0 ha surface area. Of the produce for the export market – primarily rohu, catla, mrigal and tilapia – the carps are stocked as yearlings and harvested 10 to 14 months later, often at a uniform size of 1.5 to 2 or 2.5 to 5.0 kg (see photo in Box 1). The export markets to the Near East have developed around the expatriate workers/communities of Bangladeshi and Indian origins, a classic example of the development of a market to meet a specialized community demand.

In the grow-out phase, fish are fed a mixture of rice bran/fish meal/soybean meal/ground nut cake (all locally produced), and mixed in different proportions. In some farms either farm-made and/or commercially available pellet feed – generally of 22 to 27 percent protein content by dry weight – is used. In most farms the feeds are introduced into the ponds in polyethylene bags (Ng, 2007), with minute holes to enable the fish to feed, hung on stakes, many such stakes with feed being placed in a single pond at strategic positions (Box 2). Although carp culture, and indeed freshwater fish culture is widespread in Myanmar, culture activities for export are localized.

Organization of farms and processing and export.

The major transformation of Myanmar farming systems is relatively recent and was initially alerted to by Edwards (2005). Interestingly, in Myanmar large sized farms (> 400 ha) co-exist with small sized (1–2 ha) farms, the former being confined mostly to the Yangon region and in some production being destined for export only. The development of the large-scale farming system in Myanmar was documented recently (Aye *et al.*, 2007), and it is suggested that these developments revolved around the development of export markets, primarily for rohu.

BOX 1

Myanmar is an interesting country in that its carp production which was destined for the local market has witnessed a major change over the last five years. Currently, the main carp culture areas around the capital, Yangon, and in the Ayeyarwady region culture mostly three Indian major carp species, catla, mrigal and rohu, destined for the export market, in the Near East, to cater to the expatriate Indian and Bangladeshi communities, through the latter.



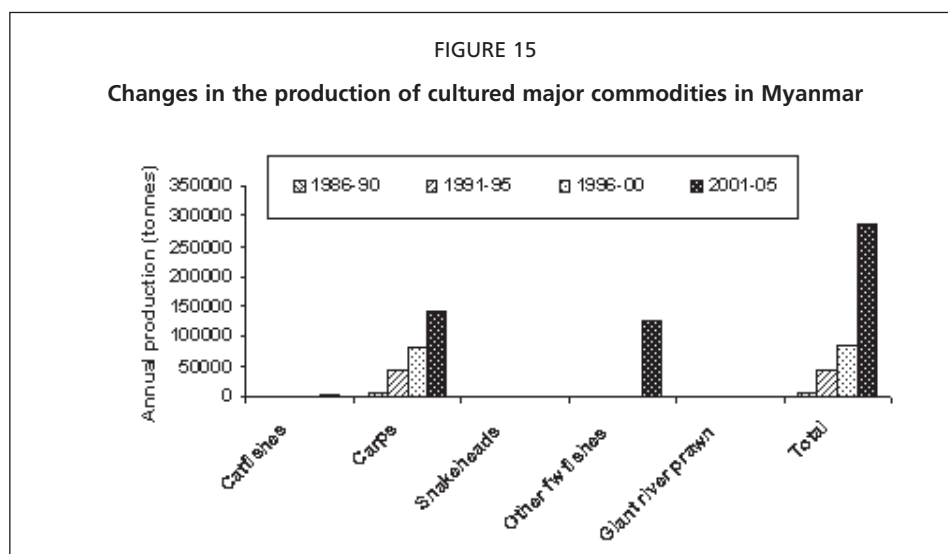
The large-scale farm ownership is variable: ranging from individual ownership to those of small companies with a few stakeholders, and often with division of labour in the farming operations. In a large enterprise the hatchery operations, larval to fingerling rearing and grow-out, could be separated in space, each component with its management structure but with overall coordination. The latter ensures maintenance of year-round production and hence the supply chains.

Myanmar large-scale carp farming, principally for export, is also gradually adopting a vertically integrated approach, whereby a few larger companies are manufacturing feed (pellet) for exclusive use in their own farming activities. In such ventures there is also a tendency to utilize processing waste as a major source of protein in the feed, either directly and/or after reducing to fishmeal. In essence there is very little waste arising from the processing sector.

The development of large-scale farming in Myanmar has had a major impetus from governmental intervention, which is mediated through the Myanmar Fisheries Federation (MFF), a Government recognized NGO, managed and run by fish farmers and persons engaged in the capture fisheries sector. MFF makes recommendations to the Government on lease applications for land for farming and subsidies (Aye *et al.*, 2007) that are provided by the Government for establishment of farms and works in close association with the Department of Fisheries, Ministry of Agriculture and Livestock.

The processing sector is also diverse in ownership and operations. Some processors own production units and are supplemented with purchases from other producers on a contract basis. The major processors and exporters, however, often rely entirely on purchases from contracted farms. The interesting fact is that there are nearly 80 processing units established in Yangon area, with more than 50 percent dealing exclusively with processing and export of rohu. On the other hand, fish exports to Bangladesh, transported directly to the port from the farm, washed, unprocessed and packed in individual polythene bags on site and loaded to cargo vessels, in the night, operate independently from processors. The margin of profit to the exporter ranges from US\$0.07 to US\$0.10 per kilogram, and this trade is monopolized by a handful, who collectively export about 5–8 tonnes/year to Bangladesh.

The Myanmar aquaculture developments and marketing thereof are one of a kind in Asia. Myanmar is blessed with a plentiful supply of good quality water and suburban underutilized land



Note: Fwf – freshwater fish species other than carps; Fwp – freshwater prawns.

BOX 2

In Myanmar for rohu, mrigal and catla culture, for export, large ponds with feed bags on stakes are the norm, and in some instances catfish is farmed at very high intensity in cages. The practices adopted are such that the final product is of uniform size.



and has been able to progress unhindered in this regard with suitable governmental support. It is questionable whether this scenario can be repeated in other countries in the region, not only in view of competition for primary physical resources but also the political systems that are in place in other countries. The other factor that is a favourable entity is that the culture practices do not operate at a super intensive level (in contrast to catfish farming in the Mekong Delta); for example, pond aeration is not used as the stocking density is maintained at manageable levels; there is no over-feeding, and for grow-out uniform sized yearlings are used. All these factors contribute to sustainability.

Marketing chains for Indian major carps, Myanmar

Two marketing chains operate in respect of cultured carps: a chain related to domestic markets and the other related to export, both of which have witnessed unprecedented growth over the last five years or so. It is acknowledged that this growth has been possible because of government patronage providing land leases and bank loans and introducing policy elements to ensure standards (Aye *et al.*, 2007).

Domestic market chain(s)

The domestic market chain in the capital city operates through a single wholesale market, San Pya. The market operates from 04.00 to about 07.00 hours, daily, and does not make a distinction between wild caught and cultured stocks. The latter, however, accounts for more than 80 percent of relatively non-high value species that are auctioned by wholesalers, approximating 40 to 60. Fish are not sold alive in this market, except for a small quantity of wild caught freshwater eels (*Anguilla* spp.) and paddy eel (*Mastecembelus* spp.). The daily transactions in the market amount to 110 to 130 tonnes, with minor seasonal fluctuation. On average, an auctioneer maintains a profit of 125 kyats/kg (1 300 kyats= US\$1), irrespective of the species, and deals with approximately 1 to 4 tonnes. The wholesale market primarily caters to vendors operating in suburban local markets. Individual vendors (e.g. ThanZay Market) purchase the daily requirements at each of the auction points (Box 3). In general, and unlike for example in the case of Thailand (see Section 3.1), vendors purchase up to five or six varieties of fish, approximating 40 to 50 kg of each. The vendors use public transport to the individual marketplaces, urban and suburban.

The selling price to the consumer does not vary significantly between finfish species, but that for the giant freshwater prawn is considerably higher. The average prices to the consumer of different

species per kilogram are: rohu: 1 100 to 1 250 kyats; mrigal: 1 600 to 2 000 kyats; and catla: 1 200 to 1 400 kyats. On average a vendor keeps a profit of 8 to 10 percent/kg on the purchase price, irrespective of the species, thereby averaging a gross profit of around 36 000 kyats/day (about US\$27), far in excess of the average daily wage in Myanmar.

Export market chains

Origin

The export market of carps, primarily consisting of rohu, catla and mrigal, and dominated by rohu, is purported to have started on a small scale, initiated by three entrepreneurs of Bangladeshi origin, when initial small consignments were shipped to Bangladesh and re-exported to the Near East (export from Bangladesh to Near East was tax exempt and hence the initial incentive to export through Bangladesh). However, this status has changed with the bulk of exports now directly destined to the Near East and a smaller proportion to Bangladesh and to other developing markets such as in the United Kingdom and a few other European countries. It is unknown whether the former practice of re-export from Bangladesh is still continuing or not, but most likely to be not.

Current status

During 2006–07, Myanmar exported 343 426 tonnes of aquatic products valued at US\$466.2 million (DoF, Myanmar, 2006). The increasing significance of the export share of freshwater cultured finfish in the total aquatic food exports from Myanmar is dominated by species other than tilapia and/or catfish, which is rather unique to the region, when over the last three years these accounted for 16 percent of the value of all exported aquatic commodities (Figures 16 and 17).

The exported freshwater commodities are dominated by carps, with rohu contributing most, both in tonnage and value. In 2006–07, 60 000 tonnes in wet weight of rohu valued at nearly US\$60 million were exported (Figure 17). The export target for 2007–08 for all fishery products and freshwater finfish are US\$750 and US\$120 million, respectively (Aye *et al.*, 2007).

Export products

The exported products are basically of four types and are also directed at different markets; they are schematically depicted in Figure 18 (also see Plate 3). In brief, these are:

- Ungutted, freshly harvested finfish, of average size of 1.8 to 2.5 kg, the great bulk of which is rohu, iced, packed in individual polythene bags at the port, and exported to Bangladesh in

BOX 3

The wholesale market in the capital Yangon operates through an auction system, commencing in the early hours of the morning, throughout the year and caters primarily to urban and suburban vendors. Individual vendors use public transport to get to their market place.



cargo holds of trawlers, taking approximately three to four days to reach the destined port (Teknat).

- Gutted, cleaned and glazed whole fish (rohu, mrigal, catla, tilapia, pangasius catfish; the latter commonly referred to as pangush in Myanmar), ranging in weight 2.5 to 4.0 kg, processed under most hygienic conditions in strict accordance with Hazard Analysis and Critical Control Points (HACCP), in processing plants of varying capacity (numbering 75 in total dealing with processing of cultured freshwater fish), packed individually and boxed in 20 to 25 kg cartons, destined mainly to the Near East, and in smaller quantities to the United Kingdom and other European markets.
- 20 to 30 tonnes/month of back gutted, primarily rohu of 2 to 2.5 kg weight destined to the Near Eastern countries.
- Catfish (*Pangasianodon hypophthalmus*) fillet of 200 to 300 g, prepared under Hazard Analysis and Critical Control Points (HACCP) conditions, packed individually, and cutlets of rohu, destined to specific markets in the Near East and the United Kingdom. However, the quantities exported are still relatively low and are expected to grow significantly in the ensuing years.

Costs and profit margins

Of the carps, rohu commands the lowest price (farmgate and export) but is produced in highest quantity, primarily as a result of the ease of producing young. For comparable size fish the price of mrigal and catla are approximately 10 to 15 percent higher. The processors and exporters rely on relatively minimal profits on a unit weight but are compensated by the large volumes that each deals with and also the fact that most exporters, processors and producers are vertically integrated so that minimal profits at each stage still provides sufficient economic viability for the entrepreneurs. As evident from the schematic diagram (Figure 18), the margins of profit at each stage of operation often is in the range of 10 to 15 percent, but still makes it a viable capital investment, most of which has also received governmental backing through the provision of suitable land leases, that could extend up to 400 to 500 ha, introduction of appropriate monitoring and quality control measures and even facilitating market developments through associated agencies such as the Myanmar Fishery Federation and its affiliated bodies.

It is also notable that there is no processing “waste” as such that is discarded, for landfills for example. In the extreme instance of vertical integration, one enterprise that deals with catfish farming and where the product is exported as fillet the head and the frame is used to produce its own fishmeal (1 tonne/day), which in turn is utilized for manufacturing pellet feed (70 tonnes/day) used exclusively for catfish production, which currently stands at 124 tonnes per month.

BOX 4

Export of cultured freshwater finfish from Myanmar has spread to many countries and has intensified over the last five years or so. Myanmar leads carp exports in the world; the quantities exported, and the earnings from among cultured freshwater finfish species are only second to tilapia exports from China and catfish from Viet Nam. Myanmar has 80 plants, of varying capacity, providing employment to approximately 2 500 dedicated to freshwater finfish processing.



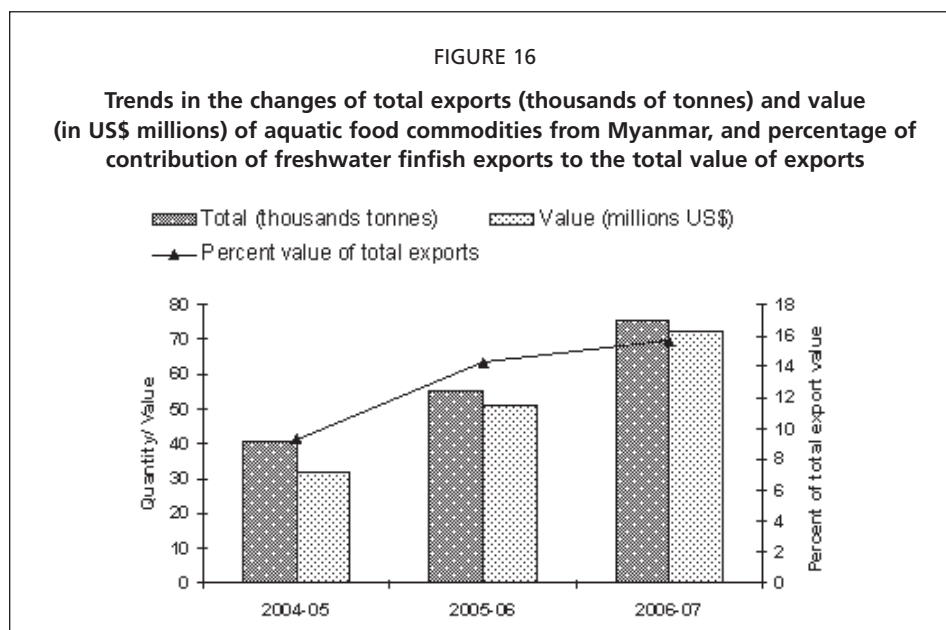
The price of exported product, rohu, to the consumer and sold whole in the different countries is as follows: Bangladesh: US\$1.30/kg; Saudi Arabia: US\$3.5/kg; Europe (Rome): approximately US\$9.00/kg (euros 5 to 6).

Production systems

In order to enable to cater to a relatively large export market, the aquaculture systems in the Yangon and Ayeyarwady Regions have undergone significant changes over the last ten years or so. Indeed, it has been reported earlier that aquaculture in Myanmar is different in scale and operation from that seen in most of Asia, where the bulk of production is from small-scale, family managed systems (Edwards, 2005; Aye *et al.*, 2007); obviously with the development of the export sector the changes are becoming even more pronounced. These practices are essentially confined to the Yangon and Ayeyarwady Regions. The farms are big, often exceeding 300 ha, with large grow-out ponds of 2 to 5 ha water surface. Grow-out farms of 500 ha are not uncommon. More often than not there is a division of labour, the fry to fingerling and fingerling to yearling rearing taking place in different systems dedicated to these purposes. A single business enterprise could have nursery, fingerling and grow-out, each separated in space, but collectively extending up to 600 to 800 ha. In grow-out all carps are stocked at a size of about 17 cm or approximately 70 to 80 g, and grown for 10 to 14 months, depending on required size for export. In all farms, locally manufactured feeds using local fishmeal and other ingredients, are used, and the feeding is often done through feed bags placed in the ponds (Ng, Soe and Phone, 2007). In view of the uniform size of yearlings stocked at harvest, the fish are also of uniform size, and consequently require very limited grading in the processing plants.

Impacts on local communities

The potential impacts on local communities could be both positive and negative. On the negative side is the availability of fish to the local community at an affordable price. In this regard the evidence available is not conclusive, particularly in view of the fact the preferred market size for local consumption is less than 1.5 kg, and fish of this size are produced in smaller farms that are not export oriented. On the positive side is the creation of employment opportunities in processing plants, in the export trade blue-collar workers, and increased labour for large sized farms. For example, the processing sector alone would provide employment for between 24 to 40 persons per tonne of processed product per year. Increased employment obviously contributes to food security and improvement of living standards.

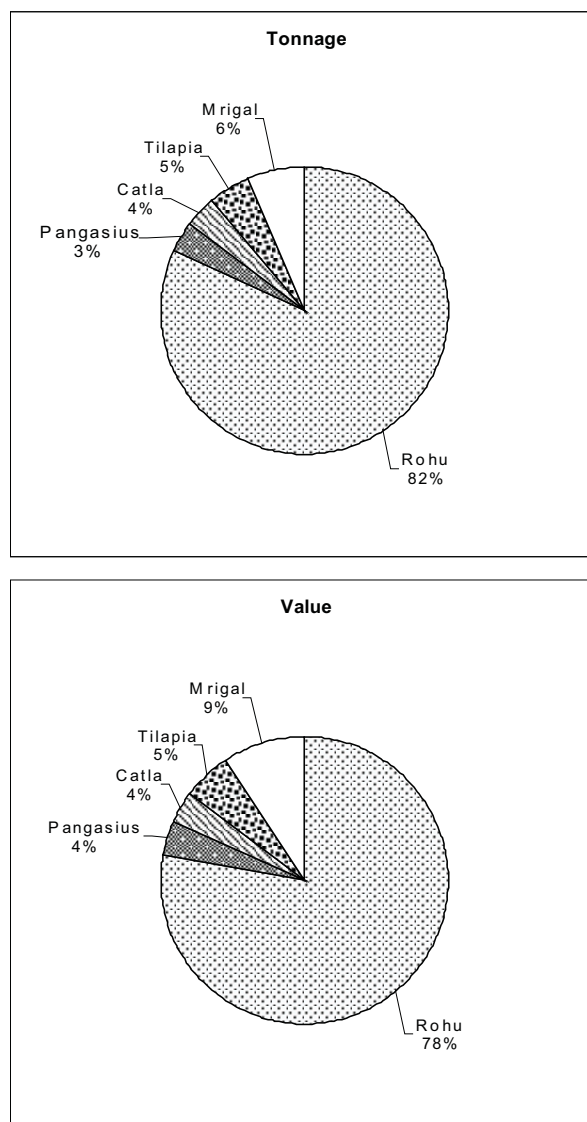


2.2.3 Viet Nam: carp culture and steps in the value chain

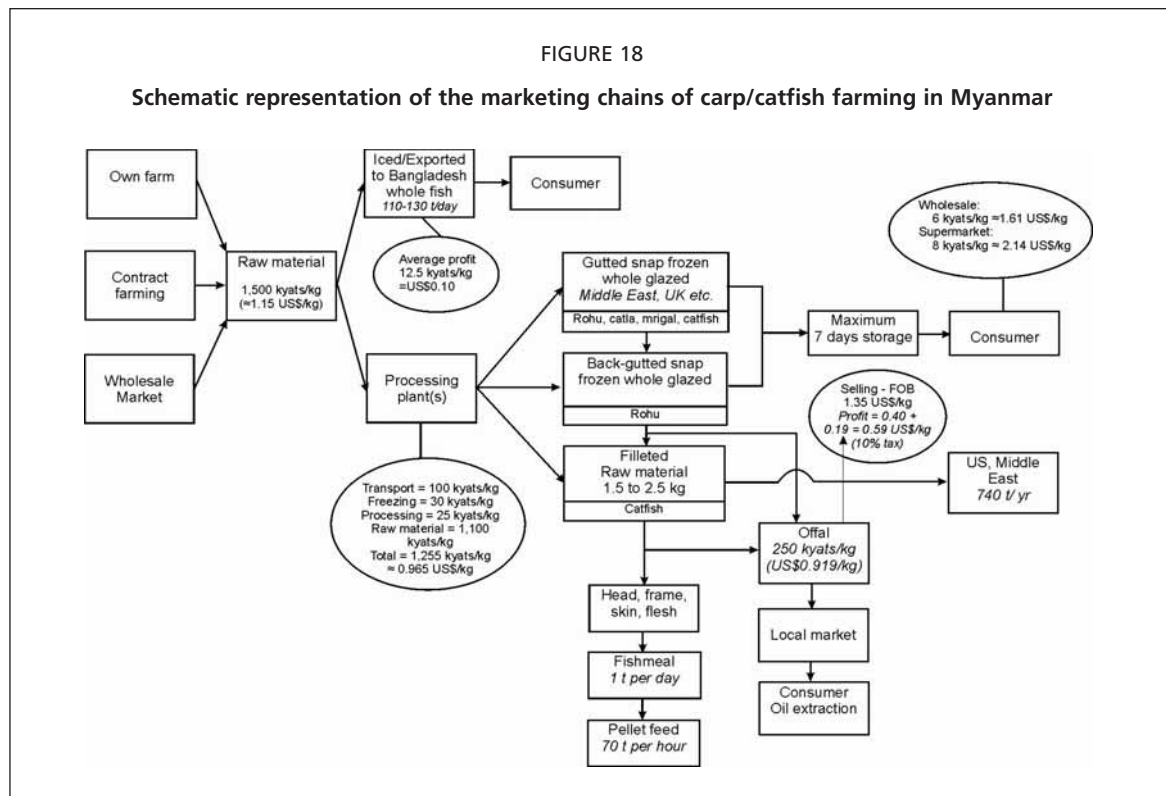
The carp farming system in the Central Highland Region, DakLak Province, was undertaken in view of the unusually high number of links that are in operation and the considerable degree of division of labour, in time and space, involved in the production cycle. The carp species cultured are grass carp and common carp, from December to August, bighead carp and silver carp from February to August, rohu and mrigal from April to September. The fish, at different stages of culture, are moved long distances: hatchlings from DakLak Province to Ho Chi Minh City for growing to fingerling stages in raceways and small intensive culture facilities, and fingerlings in turn back to DakLak Province for grow-out to market size. This is done in conformity to gain the highest efficacy of the different facilities available at each of the locations, which indirectly also permits a continued production and supply channel to be maintained throughout the year, as indicated here.

FIGURE 17

Percentage of contribution to the total tonnage and value by main freshwater cultured species exported in year 2006–07



Note: based on data provided by the Department of Fisheries, Government of Myanmar



It is interesting that the grow-out farmers still make a gross profit of approximately 9 667 dong/kg or US\$0.66, not significantly less than that in extensive channel catfish farming in Kentucky, United States (Dasgupta and Durborow, 2007); not accounting for labour costs in the case of the former. It is also important to note that in spite of the commodity changing hands through its value chain, the final product reaches the consumer at an affordable price, approximately 20 000 to 25 000 dong/kg (Figure 19).

In a manner, the above string of events in the value chain in the production and marketing of carps in DakLak province, and in the Central Highland Region of Viet Nam is relatively unusual and somewhat unique to the region. As pointed out earlier the adopted systems enable production of different species to be cultured throughout the year, and make a variety of products available to the consumer.

However, elsewhere in Viet Nam, although there is a clear division of labour in hatchery, fingerling and grow-out production steps, the products are not transported extensive distances and across provinces as in the previous case. In general in most of the other areas the middle persons visit producers, and products are sold directly and/or through a wholesaler to the consumer. Wholesalers are involved in areas/regions of relatively large population centres and therefore large markets.

A comparable physically phased out system exists in tilapia cage farming in three large reservoirs (Cirata, Jatiluhur and Saguling) in West Java, Indonesia, that collectively accounts for the production of approximately 20 000 tonnes per year, almost all for domestic consumption. The marketing chain at each stage of the farming system is very much akin to that for the carps in Viet Nam, with the only difference being the distances separating each stage of operation (hatchling production, fry to fingerling rearing and grow-out) is much less than in Viet Nam, the maximum being approximately 60 km.

BOX 5

In Myanmar very often farms are dedicated to producing for exports only. The operations of some large entrepreneurs could be vertically integrated with their own fishmeal and feed plants. The processing industry is strictly regulated and the highest hygienic conditions are maintained.



3. FRESHWATER CARNIVOROUS FISH

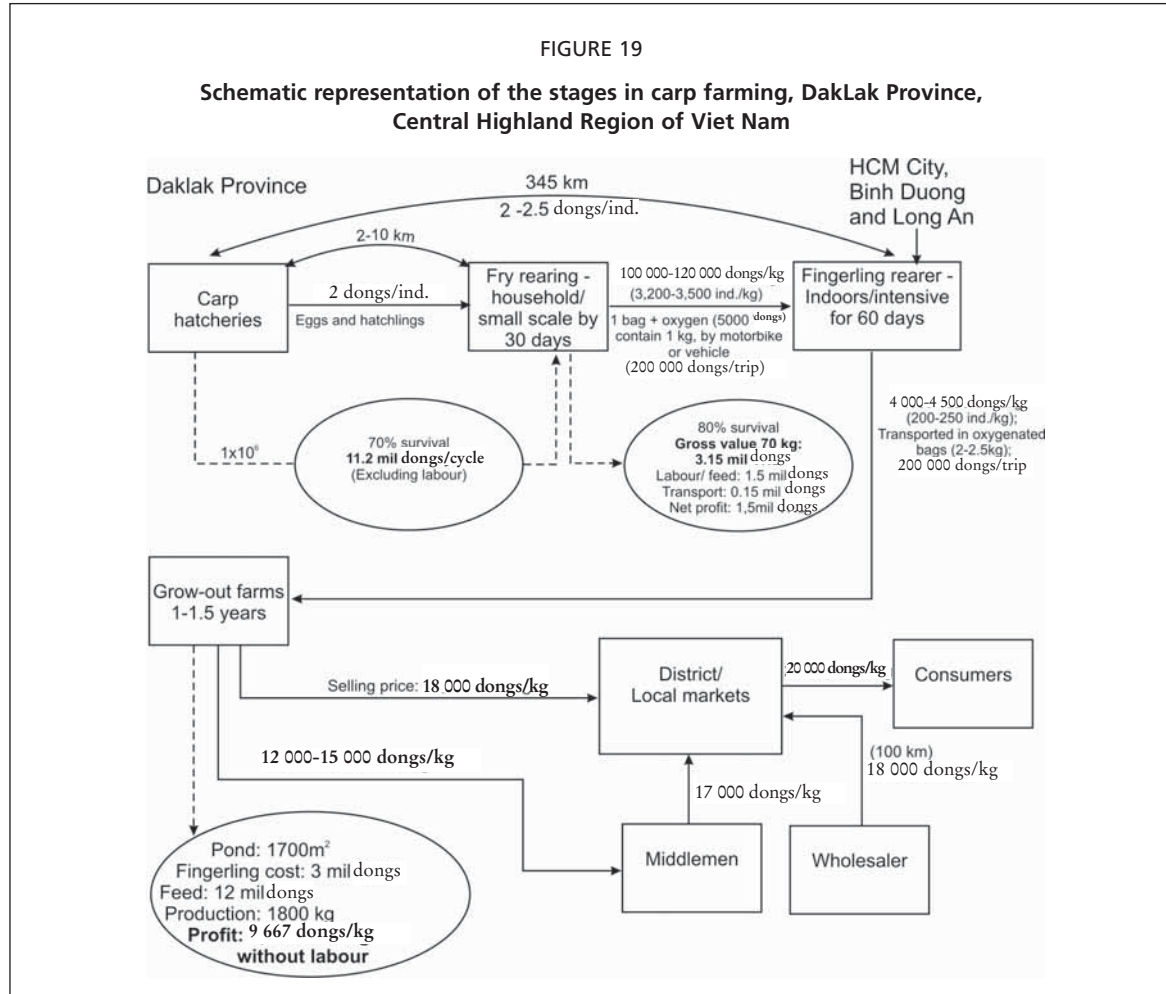
A number of species of freshwater carnivorous fish are cultured in the region, the most popular being sea bass, snakehead and catfishes. Although these three groups collectively account for only about 5 percent of total Asian freshwater finfish production, these occupy niche markets, including the very important export market for the Vietnamese Pangasid catfish, in particular tra, *Pangasianodon hypophthalmus*, concentrated in the Mekong Delta in southern Viet Nam (Le, Truc and Huy, 2007; Nguyen, 2007). Also, snakehead and catfish production have shown significant increases (Figure 20) in the last six years, but not eels. The growth of eel farming is being curtailed because of limitations of seed stocks, all of which are wild caught. Snakehead and catfish farming is predominant in Thailand and Viet Nam (see also Plate 4), to different extents, and eel farming in China.

The catfish species cultured in the region, however, vary from country to country. For example, the main species cultured in Viet Nam, which is the biggest catfish farming activity in the region, is based on the Pangasid catfishes, *P. hypophthalmus* and *Pangasius bocourti*, locally referred to as tra and basa catfish, respectively, while that in Thailand is based on the hybrid of the Asian catfish *Clarias gariepinus* and the African catfish *C. macrocephalus* (Na-Nakorn, 2004). In the past in both these culture practices, particularly in grow-out, trash fish/low value fish was the main ingredient used for farm-made feeds, and still is predominantly the case in Thailand. However, with the decrease in the market value of farmed catfish in Thailand the farmers have become more innovative and have almost totally opted out of using trash fish/low value fish in grow-out feeds, and base the farm-made feeds on poultry processing waste as the main protein source. This has enabled these farmers to remain viable. In the case of Viet Nam, the everexpanding catfish farming is increasingly using pellet feeds. Two case studies on marketing channels of snakehead and catfish from Thailand and Viet Nam, respectively, are presented.

3.1 Marketing chains for cultured snakehead and catfish in Thailand

3.1.1 Farming systems

In general, catfish and snakeheads are cultured in earthen ponds; the former is also cultured in net cages. Both groups are carnivorous, and in the grow-out stages fish are fed moist diets consisting of a mixture of trash fish/low valued fish, and rice bran (8:2), with other added ingredients in small amounts. However, as stated above, with the drop in market price of catfish in Thailand, increasingly farmers are using alternatives for trash fish/low valued fish, such as poultry industry wastes (see De Silva, Turchini and Phillips, 2007b for details). The average farm production could be as high as 5 kg/m².



3.1.2 Marketing channels

Wholesale markets

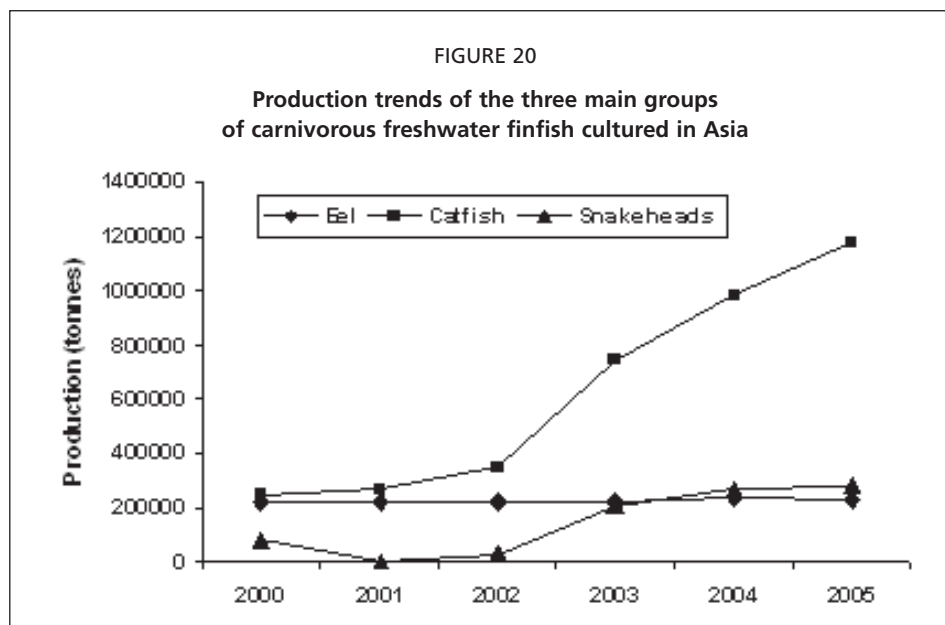
In Thailand catfish and snakeheads are often marketed live, even to the point when it reaches the consumer. Almost always the species are kept alive at the wholesalers (Plate 5). Consequently, these two commodities are rarely marketed in supermarkets, unless in a ready-to-eat state. Bangkok and its suburbs account for the highest amount of trading of these two groups of fish, catering to a population of approximately 10 to 11 million, the bulk of which is traded through five wholesale markets in the city, viz.:

- Bangkok Fishing Port Wholesale Market
- Talad Thai Wholesale Market
- Parthumthani Wholesale Market
- BangCane Wholesale Market
- Sri Mum Muang Wholesale Market

All of these markets operate through the week, almost every day in the year. Furthermore, these markets are privately owned and operated. The rental for individual wholesalers for a block – a space of approximately 10 x 10 m – is 50 000 baht/month currently, and an annual fee of 30 000 baht (as at May 2007, 34 Thai baht = US\$1) is also levied. The rental and the annual fee also include the services.

Wholesalers

Each wholesaler deals with only one commodity group, be it catfish, snakeheads, tilapias, frogs, carps and so on. The numbers of wholesalers that deal with each group of fish vary from one



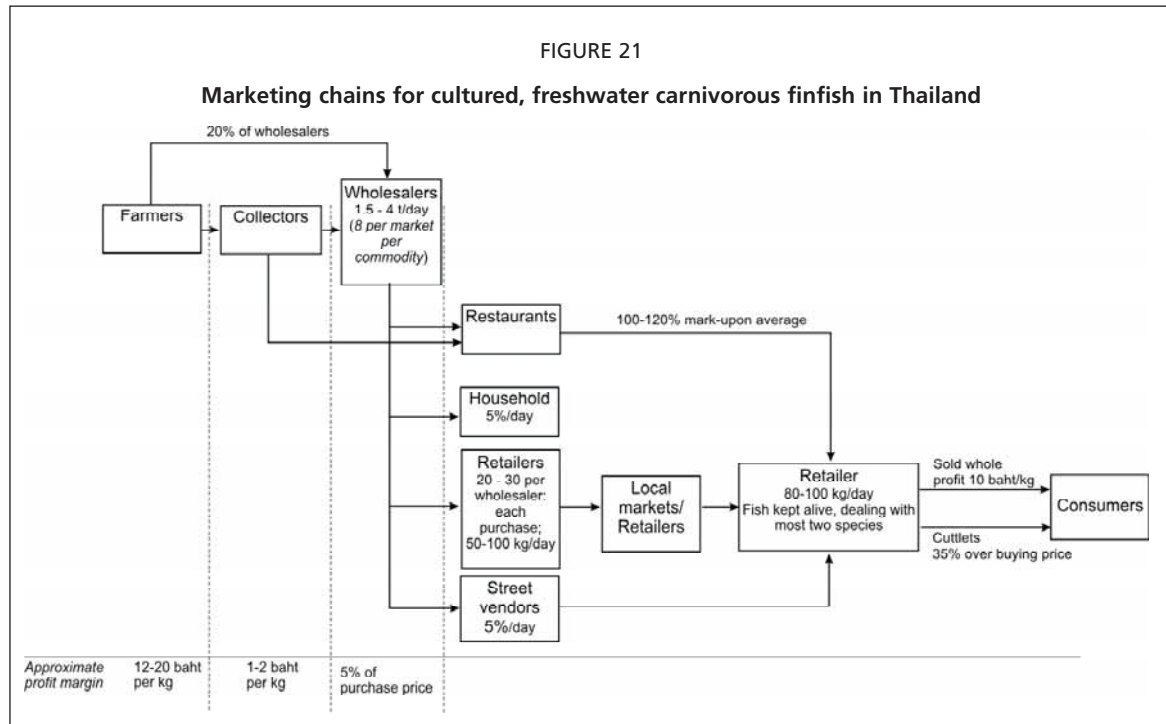
market to the other and average four per commodity group. Each wholesaler deals with 1.5 to 4 tonnes of fish per day, depending on availability and prearranged orders. Sorting of fish, by size, is often carried out on site and is manually done by an experienced hand. For each commodity the price set will vary between sizes, and most of all wild caught counterparts, which often also tend to be of bigger size, commands the highest price. For example, snakeheads of 0.4–0.6 g and >0.6 g were priced at 60 and 65 baht/kg, and slightly bigger, wild caught snakehead was priced at 85 baht/kg, approximately 30 percent higher. Catfish wholesale prices are significantly less, ranging from 27 to 36 baht/kg, depending on size, and are lower than tilapia.

On average each wholesaler had a clientele of 20 to 40 retailers who would purchase up to a maximum of 100 kg/day. The wholesalers also retail directly to consumers/households the quantities purchased, which are greater during the weekends and public holidays.

The wholesalers obtain their fish either through collectors, and/or directly from farms. It is not uncommon for a wholesaler to depend on 30 to 40 collectors (= farms) at any one time. The wholesalers retain a margin of 5 percent on the sales, which is reduced to 3 percent in the case of long-term retailing clients. This margin includes transportation costs, wages and rentals. It is often the case that most wholesalers were also owners of fish farms. On sales from the farm to retailers a profit margin of approximately 10 percent is retained generally.

Retailers

As in the case of wholesalers, in most retail outlets each will deal with only a single commodity group, or at most two, except in the case of those that sell marine fish. In the case of snakehead and catfish the retailers also keep the fish alive or in a very fresh state, but never iced. In general, and on average, a retailer will vendor a maximum of 80 to 100 kg/day, of each species, but in most cases it would be around 50 to 60 kg, depending on the market location. A retailer will mostly sell catfish and snakehead, whole. However, a certain proportion is cut into cutlets for customers. The retailers on average also keep a profit of approximately 10 baht per kilogram when sold whole, and cutlets are sold about 40 percent higher (obtain about 80 percent of the whole weight in cutlets). The market chain in the vending of snakehead and catfish, and indeed the bulk of freshwater fish cultured in Thailand, is depicted schematically in Figure 21.



3.2 Marketing chain for cultured catfish, Mekong Delta, southern Viet Nam

A major success story in global aquaculture in the new millennium could be considered as the development of catfish farming in Viet Nam, primarily in the Mekong Delta. This sector in the past, which practised on a relatively small scale – and primarily for domestic consumption – was dependent on wild caught fry/fingerlings from the Cambodian sector in the confluence of the Mekong, Tonle Sap and Basac rivers, near to the capital, Phnom Penh. With the success in artificial propagation of the two catfish species, it was primarily carried forward after a banning by the Cambodian Government of the capture of the wild caught seed stock. As evident from Figure 22 the catfish sector has reached the level of a major seafood export commodity from Viet Nam, expected to be worth US\$1 billion in 2007. The catfish farming is small scale and is conducted in cages and ponds, and the proportion of pond culture has increased over the last few years because of environmental concerns and feed costs (Le, Truc and Huy, 2007). The growth of catfish farming in the Mekong Delta has proceeded unabated over the last five years or more, and with the increased push to achieve a target of 1 million tonne production by 2010 the associated sustainability issues and environmental impacts are becoming much discussed issues.

Indeed, the total production has reached 1 million tonnes already, exceeding the Government expectations, and hand in hand the farming operations in cages have decreased markedly. Land based farming in relatively large ponds (0.5 to 1.0 ha) along the Mekong river still remains small scale, the largest single farm being only of 15 ha in 2006. However, there is a trend for the overall farm size to increase, particularly among the “large scale” farmers, some extending to as much as 120 ha, and even unit production reaching levels as high as 400 to 600 tonnes/ha/crop. The farming practices and the costs involved vary between different districts (VinhLong and AnGiang) of the Delta, and a comparison is given in Table 6. Catfish farming in VinhLong District is relatively new, and these systems had the opportunity to improve on the old practices and thereby remain more profitable.

3.2.1 Culture systems

Two primary culture systems are in operation in the Delta: cage and pond. Over the last few years the number of cage farms has decreased (Le, Truc and Huy, 2007) because of reduced water flow

resulting in production losses from disease and a death and the high cost of raw material (timber) for cage construction. The average cage size is $6 \times 12 \times 3$ m, with each farmer operating three to four cages, and the average pond size ranging from 2 700 to 8 000 m², and each farmer may operate a total of 0.3 to 3.0 ha of ponds. Stocking is done as early and/or advanced fingerlings at 3 to 4 g or 80–90 g weight, purchased at 200 or 1 800 dong per fingerling, respectively. Catfish farming in the Delta is one of the most intensive farming practices in Asia, cultured at very high stocking densities, such as for example in ponds 60–80 tails/m² and 80–120 tails/m² in pen culture, yielding 250–300 and 300–350 tonnes/ ha, respectively. In general, average yields range 300 tonnes/ha/year with each cycle being of about six months (Nguyen, 2007).

3.2.2 Market chains

Vietnamese catfish is almost totally processed, mainly in fillet form, and is exported. The quantity that is used for local consumption is estimated to be less than 1 percent and consists mostly of fish that die in transportation to processing plants. The catfish exports of Viet Nam have had to face many trade problems, and it is believed that only the timely intervention of the Government of Viet Nam and the initiatives thereof saved the industry. Indeed, the success of catfish farming and the related export markets are inducing other neighbouring countries (Indonesia, Myanmar and Thailand [Box 6]) to venture into catfish farming.

Harvested catfish, ranging in size from 1.5 to 3 kg, are kept alive and are transported by boats directly to processing plants, and as such involve very little handling. The processing plants are located upstream along the riverbanks. In most cases harvesting and transportation are contracted to other parties.

The market chain for catfish is relatively simple and is schematically represented in Figure 23. Individual farmers are contracted to processing plants either directly or through “agents”. In general, the whole stock is harvested in one day, and transported live to processing plants. Some of the transportation, particularly cage reared fish, is by boat. It is estimated that catfish processing plants provide employment to 10 to 11 thousand persons in the Mekong Delta (Le *et al.*, 2006). The information obtainable suggests the distribution of processing plants in the Mekong Delta as 15, 7 and 5 in AnGiang Province, Can Tho City and Soc Tran Province, respectively, and one each in TienGiang, TraVinh and VinhLong provinces. The profiles of three processing plants are compared in Table 7. The dress weight of the processed product averages 40 percent, i.e.

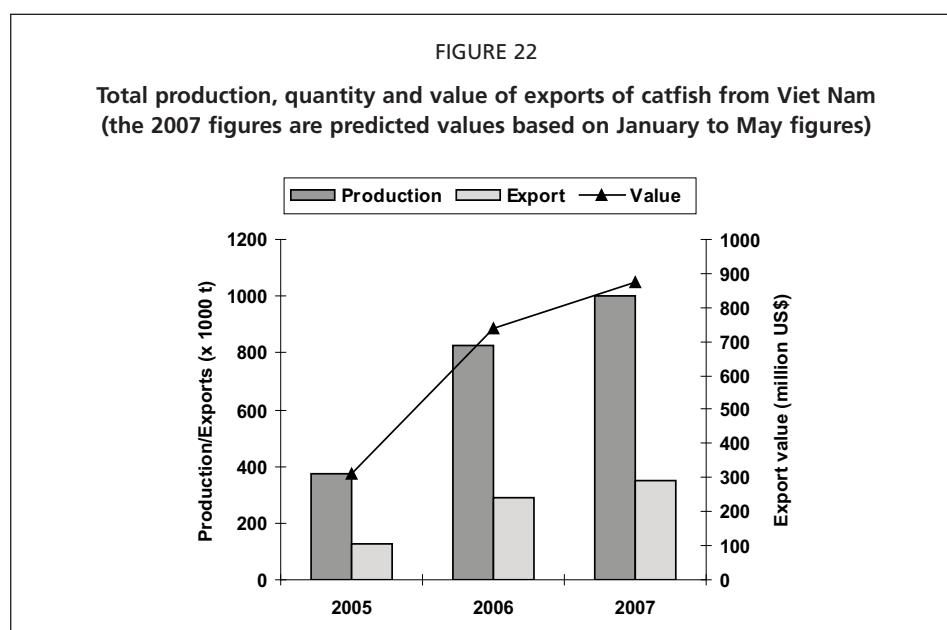


TABLE 6

Details of a survey of *P. hypophthalmus* (tra; sutchi catfish) farming in VinhLong and AnGiang Districts in the Mekong Delta. The data are based on a survey of five farms in each district

| Parameter | VinhLong | AnGiang |
|-------------------------------|---------------------------------------|---------------------------------------|
| Fingerling cost | 200-1 700 dong/individual | 1 700 dong/ind. |
| Fingerling transportation | Seller pays | 30 dong/ind |
| Stocking density | 40-50 ind. m ² | 40-50 ind. m ² |
| Grow-out period | 6-7 months | 5 months |
| Survival rate (%) | 80 | 70 |
| Harvest weight | 1 kg | 1 kg |
| Feed costs per crop | 5 184 million dong (6 000 dong/kg) | 4 480 million dong (4 000 dong/kg) |
| Average food conversion ratio | 1.5-1.6 | 2-2.2 |
| Labour cost/crop | 42 million dong | 42 million dong |
| Farm gate price | 14 000 dong/kg | 14 000 dong/kg |
| Average profit/crop | 2 291 million dong | 778.5 million dong |
| Profit/ha/month | 226 million dong | 48.6 million dong |

2.5 kilogram resulting (average cost 42 000 dong) in 1 kilogram of processed fillet (54 000 dong). Processing (labour), packing cost (packaging material and labour), and transportation is estimated at 5 000–6 000 dong/kg of processed product, leaving a gross profit of about 6 000 dong/kg of processed product or 2.5 kg of raw material. Accordingly, a 50 tonnes/day capacity plant will make a gross profit of 120 million dong/day (approximately US\$8 000), a substantial gross profit by any standard.

TABLE 7

Profiles of three catfish processing plants in the Mekong Delta

| Parameter | AnXuyen | ANVIFISH | BienDong |
|------------------------|---|---|---|
| Established | 2005 | 2004 | 2005 |
| Area (m ²) | 12 000 | 30,0 | 30 000 |
| Capacity (t/day) | 60 | 100 | 45 |
| Workforce | 700 | 1 000 | 1 500 |
| HACCP Code | DL 33 | DL 359 | DL 15 |
| Raw material | Live fish approx. 500 dong/kg; transported to site; purchase price 13 000 to 15 000 dong/kg | Live fish approx. 500 dong/kg; transported to site; purchase price 13 000 to 15 000 dong/kg | Live fish approx. 500 dong/kg; transported to site; purchase price 13 000 to 15 000 dong/kg |
| Product | Not available | Whole frozen (20%; cutlets (20%); frozen fillet (60%)) | Whole frozen (2%; cutlets (8%); frozen fillet (90%)) |
| Selling price | Frozen fillet; US\$3.1 to 3.4/kg | Average US\$3.1/kg | Average US\$3.4/kg |

4. CASE STUDY ON LAO PEOPLE'S DEMOCRATIC REPUBLIC

Lao People's Democratic Republic is a landlocked country (236 800 km²), with a population of 6.2 million and a predominantly agricultural economy (<http://www.cia.gov/library/publications/the-world-factbook/geos/la.html>). Lao People's Democratic Republic has one of the lowest GDP in Asia and has witnessed many changes in the fisheries sector in the recent past in particular related to the plateauing of the capture fisheries of its main source, the Mekong River and its tributaries, at approximately 30 000 tonnes per year, and the emergence of aquaculture as the dominant means of fish supplies to the population, which currently stands at about 110 000 tonnes. Aquaculture has grown by over 100 percent per year in Lao People's Democratic Republic over the last 2.5 years, with tilapia dominating production (FAO, 2007).