

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 dongs/individual	1 700 dongs/ind.
Fingerling transportation	Seller pays	30 dongs/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 dongs (6 000 dongs/kg)	4 480 million dongs (4 000 dongs/kg)
Average food conversion ratio	1.5-1.6	2-2.2
Labour cost/crop	42 million dongs	42 million dongs
Farm gate price	14 000 dongs/kg	14 000 dongs/kg
Average profit/crop	2 291 million dongs	778.5 million dongs
Profit/ha/month	226 million dongs	48.6 million dongs

2.5 kilogram resulting (average cost 42 000 dongs) in 1 kilogram of processed fillet (54 000 dongs). Processing (labour), packing cost (packaging material and labour), and transportation is estimated at 5 000–6 000 dongs/kg of processed product, leaving a gross profit of about 6 000 dongs/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 dongs/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 dongs/kg; transported to site; purchase price 13 000 to 15 000 dongs/kg	Live fish approx. 500 dongs/kg; transported to site; purchase price 13 000 to 15 000 dongs/kg	Live fish approx. 500 dongs/kg; transported to site; purchase price 13 000 to 15 000 dongs/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).

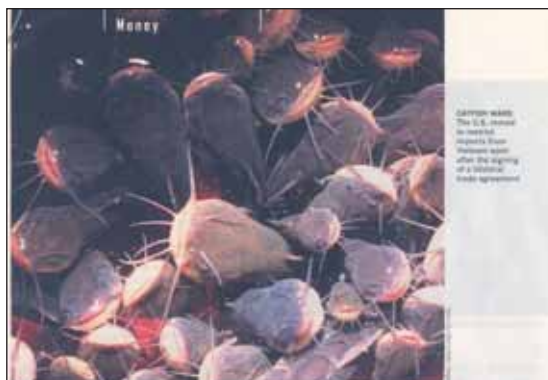
BOX 6

Viet Nam catfish exports has had to face many problems. In 2002 the United States Catfish Farmers Association petitioned the International Trade Commission (ITC) stating that fish from Viet Nam was sold in the United States at less than its production value and this was damaging the United States catfish industry. After investigation the ITC ruled in favour of the United States catfish industry, and levied tariffs ranging from 37 to 53 percent on Viet Nam's catfish exporters to stop this "dumping".

(http://www.handsontv.info/series7/04_taking_it_personally_reports/report3.html). Catfish is also seen as suitable commodity for farming, for its export potential in many neighbouring countries.



800 PPM, LITTLE FROM U.S. producers have successfully retained positions for exporters which will have Vietnamese catfish exporters today.



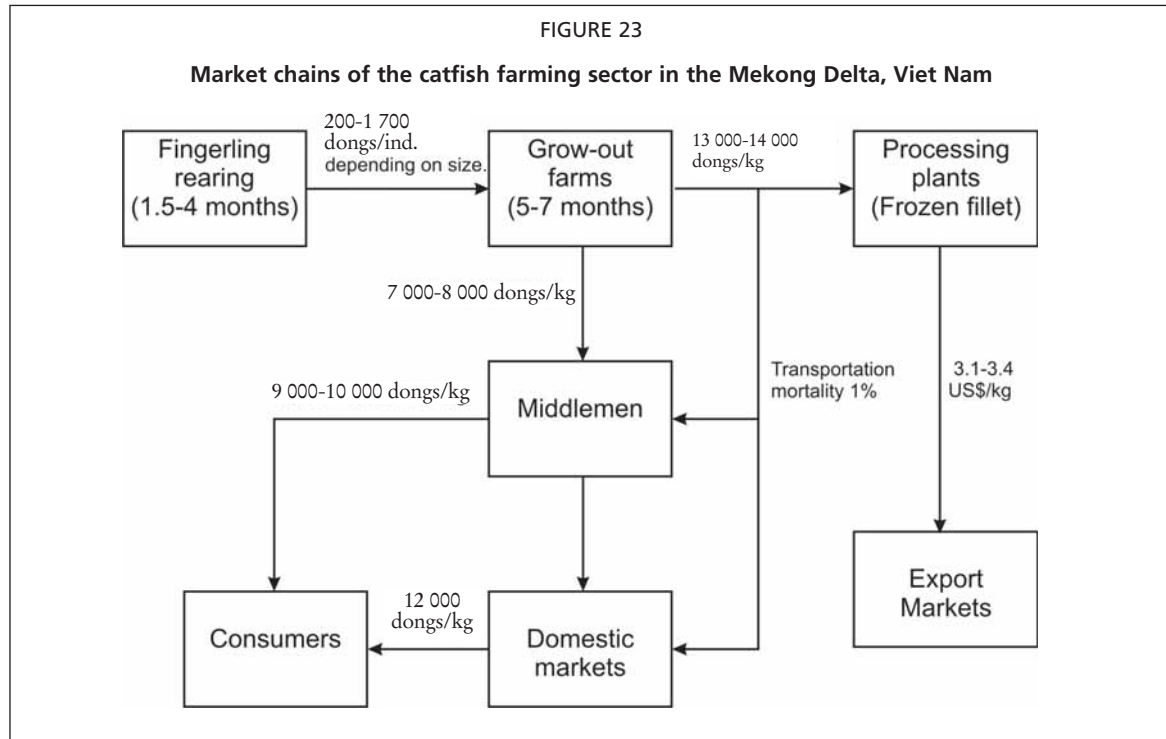
800 PPM
The U.S. market
is heavily
imported from
Vietnam even
after the signing
of a trade agreement.



Aquaculture in Lao People's Democratic Republic is very diverse and is based on a number of species groups. Most important are the tilapias (cage culture) and catfish, carps, the indigenous species, the Java barb, *Puntius gonionotus*, common carp, Indian major carp *L. rohita*, and Chinese major carps, such as silver carp and bighead carp. On the other hand, there is a concerted attempt to encourage the culture of indigenous species in preference to alien species; almost all of the latter species groups are cultured in earthen ponds. Also, almost all of the aquaculture activities in Lao People's Democratic Republic are relatively small scale, the production capacity often not exceeding 5 to 10 tonnes per year.

Lao People's Democratic Republic can be considered to be an aquaculturally emerging nation in the region, and consequently the Government is embarking on major policy developments and R & D programs. Currently, the seed production of a variety of species is from 22 and 24 Government and privately owned hatcheries, respectively. In many instances however, hatcheries lack fry to fingerling rearing facilities and consequently farmers have to stock fry and or early fingerlings. All grow-out farms are privately owned, often being small in size (1 to 2 ha). On the other hand, increasingly tilapia cage farming in rivers is becoming popular, the extent of investment being very variable. Interestingly, tilapia is available in most markets and the most commonly served dish in restaurants.

The Lao People's Democratic Republic Government is also embarking on culture-based fisheries, a form of aquaculture development program by which it wishes to engage the village communities to utilize non-perennial waterbodies of the floodplain areas and reservoir coves for fish production, an activity that has been successfully introduced in Sri Lanka and Viet Nam and



is being sustained through farming communities. In this development activity in Lao People's Democratic Republic, the village communities that are organized for farming activities are also trained in fish culture activities and are encouraged to embark on culture-based fisheries with the Government providing the seed stocks in the first year of operation. Perhaps the marketing chains in aquaculture produce are the least sophisticated and one of the simplest and most straightforward in the region (Box 7). The current market prices (in kip per kilogram; 9 500 kip= US\$1) of some cultured finfish are as follows: silver carp: 12 000; common carp: 12 000; catfish: 14 000; rohu: 14 000; and tilapia: 12 000; live tilapia: 15 000 kip. A vendor is provided the fish to be sold by the farmer and on each kilogram of fish sold, irrespective of the species and size, a net profit of 2 000 kip is retained. The markets operate in two sessions: some operating in the morning hours (07.00 to 11.00 hours) and others in the afternoon (14.00 to 18.00 hours). In general, and on average, a vendor will sell 100 kg of fish per day, in a session, and will cover two markets, thereby making a net profit of approximately 400 000 kip or US\$42 per day, considerably higher than of the daily average income in Lao People's Democratic Republic. Interestingly, tilapia is available in most markets and the most commonly served dish in restaurants. In the markets it is sold live, each vendor dealing with about 30 to 40 kg/day, making a net profit of approximately US\$0.05–0.08/kg.

In Asia in general, value adding to cultured carps is not practised widely, perhaps with the exception of Lao People's Democratic Republic. However, this value adding is done on a household basis, particularly with cultured commodities. Value adding of wild caught fish is a common practice, however, often being dried an/or made into fish sauces or fish paste, the latter on a semi-commercial basis (Plate 6).

4.1 Culture-based fisheries in Lao People's Democratic Republic

Culture-based fisheries, a form of community managed aquaculture activity, rapidly developing in some Asian countries (De Silva, 2003), is practised to a limited extent in Lao People's Democratic Republic. This activity is on the upsurge in Lao People's Democratic Republic where there are small non-perennial waterbodies in floodplain areas and reservoir coves. Culture-based fisheries have been successfully introduced in Sri Lanka and Viet Nam and are being sustained through the farming communities, and the Government of Lao People's Democratic Republic is attempting to

emulate this success and increase village fish consumption and provide supplementary benefits to farmers through aquaculture.

The local community, often comprised of rice paddy farmers, has ownership of the respective waterbodies that are engaged in this activity. The basic input to the production system are fingerlings, the quantity often determined on the previous years return and profits, and are netted to prevent fish escape, through any connecting channels, to the primary source of water. The Government intervention is confined to subsidizing the seed stock supply for the first growth cycle and providing the necessary extension services with regard to species to be stocked, managing the waterbody and assisting in harvesting. The stocked fish feed on the naturally produced food, which may be enriched through fertilization at infrequent intervals.

The relatively small returns from ongoing culture-based fishery activities in Lao People's Democratic Republic have a well organized marketing system, and the products are mostly directed to local markets. Essentially, an auctioning system operates, where the community managing the activity determines the expected price for each species group, and the highest bidder for each group purchases the harvest (Box 8). The fish are then taken to small village markets for direct sale to consumers with a markup of 15 to 20 percent on the purchase price. The product is sold fresh and on the same day, without ice. During the harvest a number of species groups occur, which includes the stocked fish species (40 to 50 percent survival) and naturally recruited species, among which are catfish species and snakehead and tilapia.

5. OTHER COMMODITIES

5.1 Trash fish/low value fish

Trash fish/low value fish use in aquaculture has attracted much attention (New, 1991, 1997), and remains a controversial issue, in regard to the use of a limited biological resource (Naylor *et al.*, 2000), ethical and moral grounds (Naylor, Williams and Strong, 2001), although often refuted. However, this study does not attempt to analyse and/or evaluate these aspects, which have been done previously (Funge-Smith, Lindebo and Staples, 2005; De Silva, Turchini and Phillips, 2007), but to deal into the aspects of market chains on trash fish/low value fish, of which a significant quantity is used by small-scale marine finfish farmers in Asia, and the production of this resource is essentially based on artisanal fishers. Accordingly, the information provided here is from two sources: that from the Mekong Delta, southern Viet Nam, based on a study by Sinh (2007) and that from a survey conducted in 2007 by the author.

BOX 7

The marketing of cultured commodities in the Lao People's Democratic Republic is simple and straightforward: the market vendor deals directly with the producer. There is no wholesale market per se. Photos: a vendor dealing with cultured produce; tilapia is sold live and one selling wild caught fish. All vendors deal with a variety of aquatic food commodities.



5.1.1 Mekong Delta, Viet Nam

In the Mekong Delta both trash fish/low value fish of both marine and freshwater origin are available; the former supply being predominant and the latter being mostly available during the flood season. In essence three market chains are recognizable in dealing with the disposal of the resource. These are:

- marine trash fish/low value fish marketing chains that cater directly to fish farmers;
- marketing chain (essentially seasonal) for trash fish/low value fish of freshwater origin;
- marketing chain that principally caters to the fishmeal plants.

Marketing chain catering to fish farmers

Marine trash fish/low value fish production is based on gillnet boats and trawlers. Gillnet boats are often used for fishing in the near offshore areas with an average capacity of 152.3 CV and an average number of 2.6 fishing trips per month. Each fishing trip, one gillnet boat had an average catch of 2 223 kg of fish and an average total production per year of 43 752 kg. Among the total caught, 30.0 percent was trash fish/low value fish, and for trawls 2 119 kg; 94 188 kg and 39.0 percent, respectively (Table 8). Small and near shore fishing boats were reported to capture smaller fish and trash fish/low value fish, in particular trawl net fishing boats. Results from other studies have shown that the proportion of trash fish/low value fish of marine origin have increased from about 20 percent up to more than 40 percent within ten years (College of Aquaculture and Fisheries, 2006). The marine fish were mostly sold to wholesalers (93.7 percent for gillnets and 98.7 percent for trawl nets).

Fresh and brackish water fishing

Fishing (fresh and brackish water) is a household activity in the Mekong Delta, and intensifies in the flood season. About 69 percent of households in the Delta fished, of which about 45.3 aimed to improve household income, 30.8 percent also wanted to catch freshwater wild fish for food, 21.4 percent for leisure during flood season (often from August to the end of November). About 6.8 percent of 117 fishing households also aimed to catch wild fish and trash fish/low value fish for feeding cultured stocks (Table 9). The marketing chains of the marine and freshwater trash fish/low value fish in the Mekong Delta are schematically depicted in Figure 25. It is important to note that there could be many layers/links in the value chain, and that all the landings do not necessarily follow the whole chain.

TABLE 8
Marine trash fish/low value fish production in the Mekong Delta region and its usage

Description	Gillnet (n=10)	Trawl net (n=10)	Total (n=20)
Total production/year (kg)			
Mean	43 752	94 188	68 970
SD	26 888	136 917	99 457
Trash fish in catches (%)			
Mean	30.0	39.0	34.5
SD	38.9	20.1	30.5
Min	0.0	5.0	0.0
Max	80.0	60.0	80.0
Marketing of products (%)			
Structure of total production			
Household consumption	0.0	1.3	0.7
Self retailing	6.5	0.0	3.3
To the wholesalers	93.5	98.7	96.1
Structure of total value			
Household consumption	0.0	2.5	1.3
Self-retailing	33.5	0.0	16.8
To the wholesalers	66.5	97.5	82.0

Source: modified after Sinh, 2007.

BOX 8

The community determines the expected price for each species group and is made public for the prospective buyers, who bid. The proceeds are shared among the community members based on the extent of inputs into the management, e.g. keeping watch, in the grow-out period of 4 to 6 months. Photos show the price list posted for auctioning and fish transported for sale in tractors.



TABLE 9
Use of wild caught fish (in kg) per household, in the flood-prone areas in the Mekong Delta

Description	2000	2006
Total fish production/ year (kg)		
Mean		
SD	2 115	1 267
Minimum	7	10
Maximum	15 000	12 480
Percent usages (%)		
Sold	66.0	62.7
Household consumption	32.2	32.7
Used as the feed for aquaculture	1.8	4.6

Source: Sinh et al., 2007.

Marketing chain for catering to fishmeal plants

The great bulk of trash fish/low value fish produced in the Mekong Delta, as expected, is processed in one form or the other, the most predominant being the conversion into fishmeal. Fishmeal plants in the Mekong Delta purchased about 29 916 tonnes/year of trash fish/low value fish, of which 63.3 percent was from a number of wholesalers and/or other companies, 20.0 percent directly from fishers, and the remainder from collectors. Each wholesaler traded about 2 247 tonnes/year, 61.1 percent directly from fishers, 33.3 percent through other wholesalers, and the remainder from collectors. The average price of fish bought by the wholesalers was 3 600 dongs per kg (\pm 1 300) and the reselling price was 4 400 dongs per kilogram (\pm 1 700). The average marketing costs was 183.7 dongs per kilogram, which provided a marketing profit of 635.9 dongs per kilogram. The average price of trash fish/low value fish bought by the fishmeal plants, however, was 2 800 dongs per kilogram (\pm 100). The average production of fishmeal was 7 479 tonnes/year and was sold at the average price of 13 000 dongs per kilogram (\pm 500). The average marketing cost was 284 dongs per kilogram of this raw material, which provided an average marketing profit of 166 dongs per kilogram of raw material. It was reported that 80.6 percent of the fishmeal produced was channelled to feed processing plants, 26.7 percent through a network of wholesalers, and the remainder was exported. The relevant marketing chain(s) involved are schematically shown in Figures 24 and 25. The main marketing costs to wholesalers were for the hired labour, preservation, transportation and communication, while labour costs, fuels/electricity/water and transportation were the major annual cost items to fishmeal plants. All in all the estimated gross profit on the raw materials for the fishmeal plants was US\$221 378 per annum (US\$1 = 15 000 dongs).

5.1.2 Thailand (Chanthaburi Province)

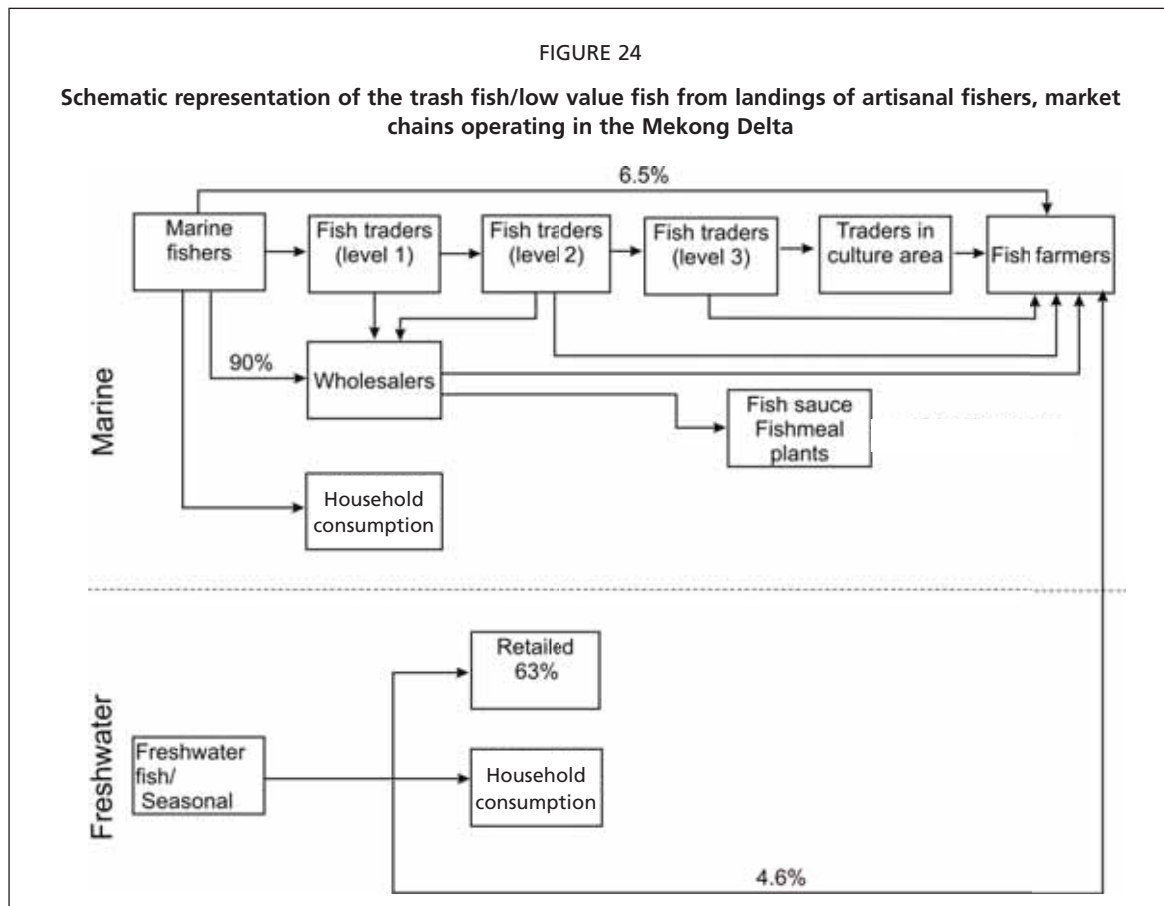
The above province, categorized under Coastal Zone 1, is an important area for marine finfish, shrimp and bivalve culture, and has landing sites also for the coastal marine fisheries. In this region, cage and pond marine fish farming – practised as small-scale holdings – is also popular (Department of Fisheries, 2006). The main and in most instances the only feed source used in grouper culture in this region is trash fish/low value fish, obtained from the local landing sites.

Bivalves (Thailand)

The latest figures (2005) for Asian cultured mollusc production are 8 916 320 tonnes and account for 72 percent of the global production. Of cultured molluscs more than 85 percent is bivalves. The cultured bivalve in Asia represents 88 percent of the total mollusc production, and Thailand is one of the leading countries in this regard (FAO, 2007), accounting for approximately 20 percent of this production. Indeed, shellfish culture in Thailand accounts for nearly 50 percent of all mariculture in the country (DoF, 2006), and is predominantly mussel culture. In Thailand the most popularly cultured bivalve is the green mussel. Of the cultured mollusc production of 358 758 tonnes in Thailand in 2004, green mussels, *Perna viridis*, accounted for 73 percent, the rest being bloody cockles and oyster. It is estimated that there are 3 112 mussel farming operations covering a total area of 14 101 ha (average farm size of 4.5 ha) in Thailand. Of the cultured mollusc only a very small proportion (about 5 percent) of cultured molluscs is exported, and a very small quantity is processed (dried).

Culture practices

Green mussel culture is practised in almost all the Thai coastal provinces to varying intensities. All green mussel culture in Thailand is based on natural spat settlement, and both bag and rope culture on rafts are practised in shallow, sheltered bays (Box 9). In essence the mussel culture practices are small-scale operations, each farmer operating a few rafts. In general, mussel culture is



low labour-intensive operation with the inputs being highest during the settlement phase to ensure that overcrowding is avoided and a less regular cleaning of the bags/ropes/stakes of settlement of unwanted organisms, and keeping regular watch of the stocks.

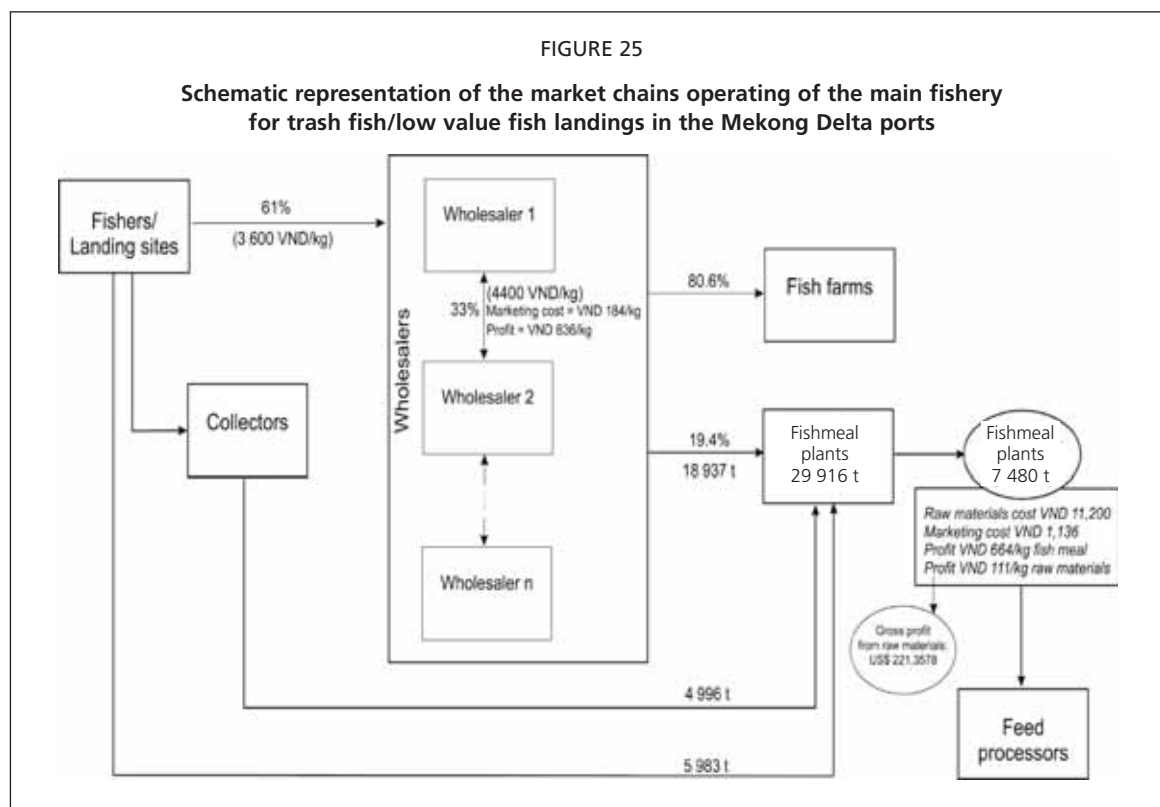
Mussel farming originated in Thailand through the entrepreneurship of small farmers, who often tended to be poor and living in the vicinity of sheltered bays, and who had generally previously been engaged in capture fisheries. Over the years the farming has been regularized by the Government, with an average farmer being levied a fee of 200–300 baht/year (34 baht= US\$1), primarily as a regulatory measure, and very rarely does the farming operation change hands. It is important to mention that the levies charged for cockle farming in intertidal flats are considerably higher, large areas (200 to 300 ha) of a flat being leased to single large-scale operators. The levies in the latter instance range from 500 to 625/ha/year.

Often the average raft size is 1 600 m², with ropes at 1 m intervals (Tunkijjanukij and Intarachart, 2007). Mussel is harvested at an average shell length of 6 to 7 cm, at a total weight of 20–25 g and a meat weight of approximately 12 to 18 g. Mussel farming is considered to be profitable and a low-cost investment, for example with yields of approximately 10 to 12 tonnes per hectare, valued at about 62 000 baht (approximately US\$1 770).

Market chains

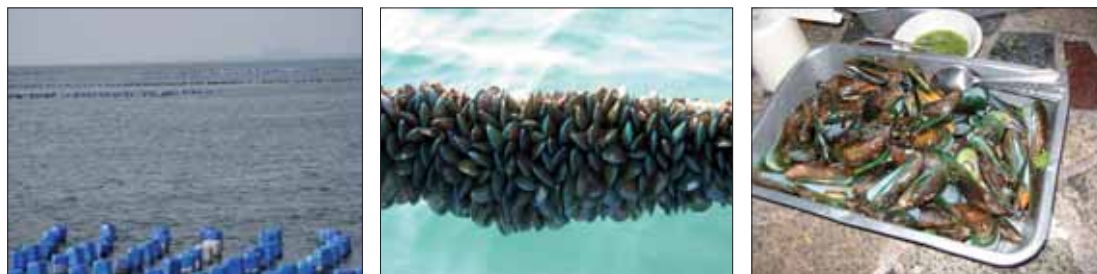
Almost all mussel harvests are marketed locally, with the restaurant trade being the main outlet. Areas of mussel cultivation are generally densely populated and are centres of seafood restaurant trade, which in Thailand are well patronized by the local communities throughout the year.

There appears to be very limited organizational structure among mussel farmers, each operating independently. However, the farmers supply mussels to restaurants on a regular basis, and a small proportion is bought up by small suburban vendors who sell directly at small markets or on the roadside. The latter on average purchases at 20 baht/kg/day, including



BOX 9

Mussel culture is the most important shellfish culture practice in Thailand, and is conducted in shallow, sheltered bays. It is a relatively low-cost activity but a profitable one. Almost all of the produce is consumed locally, mainly through restaurants, and the associate market chains are relatively straightforward. Photos: typical raft culture operation; mussel rope ready for harvesting; ready for consumption.



transportation costs, not exceeding 10 kg at any one time, and sell with an average markup of 20 percent. The restaurateurs on the other hand, purchase relatively large volumes and keep the mussels alive in the restaurant “live fish” facilities. The farmgate price of cleaned up mussel to restaurateurs, which is marketed through middlepersons, is 6 baht/kg.

6. WAY FORWARD

It is evident that relatively less high value finfish plays a crucial role in providing an affordable animal protein source to local consumers as well as income generation to the community through its exports and associated processing sectors, and marketing systems. The emergence of export markets for such commodities is a relatively new development, and it is evident that such markets are being developed for newer commodities, which were not considered to be exportable in the past. In this regard it is important that all encouragement and opportunities be provided to sustain and improve the current developments, particularly for newly emerging countries involved in exports of relatively less high value finfish. Perhaps regional initiatives are needed to further build upon the existing capacities in the processing sectors related to such exports, especially so in relation to ecolabelling and certification procedures.

There are very few in-depth investigations on the value chains of relatively less high value finfish. Lack of such studies has in all probability hampered potential improvements and consolidation thereof. Regional initiatives in such fronts will not only help the farmers and the exporters to bring about improvements at each link of the value chain but also thereby contribute to sustainability of the sector as a whole. Increasing the emphasis on exports can also be a double-edged sword; on the negative side is the desire to increase production through intensification, often beyond the carrying capacities of the waterbodies. A good such case is the catfish cage culture practices in the Lower Mekong River, forcing a shift to pond culture. It is important, therefore, for authorities to recognize limitations to intensification and growth of a sector and take measures based on scientific studies to avoid intensification and expansion becoming counterproductive.

In the region, one of the desirable initiatives that has occurred is to utilize the processing waste to manufacture fishmeal and extract fish oil. This trend has gained much momentum over the past few years. Not only does this trend entail a good procedure for waste management, but it also has enabled the profit margins at crucial links to be maintained and prevented overpricing of the products. In this regard, significant improvements could be achieved in the relevant technologies, and such improvements will contribute to alleviating the dependence on the fishmeal requirements of the sector from traditional sources (De Silva, Turchini and Phillips, 2007): a process and an initiative that needs to be encouraged from a global perspective.

Most developments of the market chains in relatively less value cultured commodities in Asia have revolved around finfish only. The value chain of other commodities, such as molluscs and seaweeds, remains less developed, and indeed has attracted limited attention.

Seaweeds are a major cultured commodity in Asia; current production is estimated at 4.78 tonnes, valued at US\$2.11 billion, accounting for nearly 99 percent of global production and in value. Moreover, seaweed culture operations are mostly carried out by women, and in most countries in Asia remain household farming enterprises. The market chains in respect of seaweeds are little known and have to be developed to ensure that farmers are suitably rewarded.

7. CONCLUSIONS

It is noteworthy that in Asia fish are a significant component of the daily food basket, far exceeding that of the other continents. Equally, and perhaps somewhat surprisingly, freshwater fish constitutes the far higher component of the “fish component” in the countries for which data are available, and as such highlights the need for further studies on such aspects in other countries, possibly even in greater depth to assess the role of cultured fish *per se* in the consumption patterns throughout the region.

In Asia, as apparent from the foregoing sections, the predominant number of freshwater finfish species that are produced in large quantities, marketed and consumed are only a few, even though the Asia and the Pacific region is reputed to culture 204 species of the total globally cultured of 336 (Subasinghe, 2006). Among the most important freshwater finfish groups cultured in Asia are the carps, catfishes and snakeheads, and exotic tilapia, all of which can be considered as relatively non-high value species. Most of the culture systems of these species are small scale and are family managed. The adopted practices, even for any one species group or a single species, are very diverse, ranging from the less intensive integrated farming systems and community managed culture-based fisheries to intensive pond and/or cage culture systems. Apart from very exceptional instances, the carp exports from Myanmar and catfish exports from Viet Nam and Myanmar, almost all of the relatively non-high value cultured commodities, there is no value addition, and the commodities are marketed in a fresh state. In this study, tilapias were not considered but this is also one group where there is value addition of the exports. The other notable factor with these commodities is that these also cater to the local demand, with the exception of the specialized carp farming systems in Myanmar, which are destined for export, frozen and on ice, to a niche market in the Near East and fast extending into the United Kingdom and a few other European countries.

Overall, it is rather disconcerting that the price of almost all the commodities under consideration has shown a declining trend. The farming systems have managed to remain viable through improved techniques and adoption of other cost saving measures, one of the principal among the latter being the successes in reducing feed costs, best exemplified by the case of catfish farmers in Thailand.

The market chains associated with the different farming systems and commodities farmed are equally diverse and reflect the production outputs and the general living standards of each country. The marketing chains can be rather straightforward as in the case of Lao People's Democratic Republic or with multiple links in the chain as in Thailand and Viet Nam. In most instances at each link, the profit margins reached are rather small, and tend to be generally fixed, often not exceeding 20 percent. The marketing chains are also linked to cultural traits. For example, in Thailand where consumer preference is for live catfish and snakehead, the corresponding marketing systems, irrespective of the number of links involved, are geared to keeping the fish alive through the value chain until it reaches the consumer.

The emergence of large-scale exports of freshwater cultured finfish in particular – most notably catfish from Viet Nam and rohu and other major Indian carps from Myanmar, as well as tilapias –

have generated a processing industry for these. These processing industries maintain the strictest hygienic conditions and conform to Hazard Analysis and Critical Control Points (HACCP). Most importantly these initiatives have generated significant employment opportunities, which are beginning to impact on food security and general well-being for individuals engaged in the industry, as well as contributing significantly to the GDP of the countries. It is also important to note that markets can be initiated and literally created with the proper identification of an appropriate consumer clientele.

It is important to take note that the export of freshwater finfish, which are mostly considered as a relatively less high valued commodity, is becoming increasingly important to Asia (Table 10).

TABLE 10
Amount (tonnes) and value (US\$ millions) of the exports of the three major finfish commodities from Asia. (The tilapia exports are only in respect to those to United States of America, and the value is based on 60 percent of the average wholesale value in the United States of America – based on Josupeit [2007].)

Commodity	2005		2006	
	Amount	Value	Amount	Value
Tilapia ^a	109 700	271.191	135 300	340.829
Catfish ^b	125 000	312.5	286 600	736.870
Carp (rohu) ^c	42 817	36.92	59 646	53.317

Note: a: frozen whole and fillet;
b: fillet;
c: frozen whole and chilled

Data sources: tilapia: <http://www.globefish.org/index.php?id=4> *.; carps: DoF, Myanmar

The total exports of three species groups from Asia in 2006 exceeded US\$1 billion, and the catfish exports from Viet Nam alone in 2007 is expected to exceed this amount. Increasingly new markets are sought and are being developed for such commodities as best exemplified in the case of rohu from Myanmar. The development of exports also dictates that corresponding developments take place in the processing sector. The latter is labour-intensive and consequently provides significant increases in employment opportunities, particularly in densely populated urban areas where processing plants tend to be located, contributing to food security and general well-being. Also, in most instances the bulk of the employees tend to be female, and the employment opportunities provide a gender balance in the contribution to household income and thereby empower the women.

All in all it is expected that the trend of export of cultured freshwater commodities will increase gradually, and apart from the ones already exported, there are significant opportunities for other commodities to take centre stage, most notably the giant freshwater prawn. The latter has received only marginal attention as an export commodity, a scenario that is likely to change in the foreseeable future, and attention with regard to improving processed product quality and developing untraditional markets is warranted.

7.1 Food security – job creation

The contribution to food security through the marketing channels of relatively less valued fish has not been addressed hitherto, and indeed has gone unnoticed in all quarters. Evidence has been presented in the foregoing sections that some of the recent aquaculture developments of relatively less valued species, such as the export industries of rohu in Myanmar and catfish in the Mekong Delta in South Viet Nam, have been instrumental in generating many thousand employment opportunities, which in turn indirectly provide an avenue to food security. It is equally notable that most employment opportunities in the fish processing sector are for women, positively impacting on empowering the socio-economic status of whole communities.

8. REFERENCES

- Aye Khin Maung, Ko Lay Khin, Win Hla & De Silva Sena, S. 2007. A new freshwater aquaculture practice that has successfully targeted a niche export market with major positive societal impacts: Myanmar. *Aquaculture Asia*, XII (4), (in press).
- Balraj Khobragade & Sonawane, S.R. 2002. Economic Analysis of Freshwater Fish Marketing in Aurangabad city (M.S.). *Journal Fisheries Economics and Development*, Vol. V, No.1.
- Balon, E.K. 2004. About the oldest domesticates among fishes. *Journal of Fish Biology* 65 (Supplement A), 1–27.
- Cardia, F. & Lovatelli, A. (In press.) A review of cage culture in the Mediterranean. *FAO Fisheries Technical Paper*.
- Dasgupta, S. & Durborow, R. 2007. Profitability and management of low-tech catfish farming: the case of Kentucky. *World Aquaculture* 38 (1), 14–18.
- De Silva, S.S. 2003. Culture-based fisheries: an underutilized opportunity in aquaculture. *Aquaculture* 221, 221–243.
- De Silva, S.S., Subasinghe, R., Bartley, D. & Lowther, J. 2004. Tilapias as exotics in the Asia-Pacific: a review. *FAO Fisheries Technical Paper* 453, 63 pp.
- De Silva, S.S., Nguyen, T.T.T., Abery, N.W. & Amarasinghe, U.S. 2006. An evaluation of the role and impacts of alien finfish in Asian inland aquaculture. *Aquaculture Research*, 37, 1–17.
- De Silva, S.S., Turchini, G.M. & Phillips, M.J. 2007. Towards unravelling all uses of trash fish/low value fish for animal feeds. In press.
- Department of Fisheries. 2006. Fisheries Statistics of Thailand, 2004. No 4/ 2006. Department of Fisheries, Ministry of Agriculture and Cooperatives, Government of Thailand, 91 pp.
- Dey, M.M. & Garcia, Y.T. 2007. Demand for fish in Asia: a cross-country analysis. In: 2007. Economics and market analysis of the live reef-fish trade in the Asia and Pacific region, Johnston, B. (ed.), *ACIAR Working Paper 64*, 13–42. Australian Center for International Agricultural Research, Canberra.
- Dey, M.M., Paraguas, F.J. & Alam, Md.F. 2001. Cross-country synthesis In Production, accessibility, marketing and consumption patterns of freshwater aquaculture products in Asia: a cross country composition. *FAO Fisheries Circular*, No. 973, Rome, FAO. 275 p.
- Edwards, P. 2005. Rural aquaculture in Myanmar. *Aquaculture Asia*, X (2), 5–9.
- FAO & NACA. 2003. Myanmar aquaculture and inland fisheries. RAP Publication, 2003/18, 60 pp.
- Feare, C.J. 2006. Fish farming and the risk of spread of avian influenza. *Bird Life International* (http://www.birdlife.org/action/science/species/avian_flu/index.html)
- Funge-Smith, S. Lindebo, E. & Staples, D. 2005. Asian fisheries today: the production and use of low value/trash fish from marine fisheries in the Asia-Pacific region. RAP Publication 2005/18. FAO Regional Office for Asia and the Pacific, Bangkok, 38 pp.
- Gupta, M.V. & Acosta, B.O. 2004a. A review of tilapia global farming practices. *Aquaculture Asia* IX (1), 7–12.
- Gupta, M.V. & Acosta, B.O. 2004b. From drawing board to dinning table: the success story of the GIFT project. *NAGA World Fish Center Quarterly* 27, 4–14.
- Hardy, R.W. 2001. Urban legends and fish nutrition, Part 2. *Aquaculture Magazine* 27 (2), 57–60.
- Hu, B. & Liu, J. 2000. 200 Questions about Integrated Fish Farming. Beijing: China Agricultural Press.
- Jayanthi, M., Rekha, P.N., Kavitha, N. & Ravichandran, P. 2006. Assessment of impacts of aquaculture on Kolleru Lake (India) using remote sensing and Geographical Information System. *Aquaculture Research*, 37, 1617–1626.
- Jhingran, V.G. 1991. Fish and Fisheries of India. 1991. Third Edition. Hindustan Publishing Corporation (India), Delhi, 727 pp.
- Johnston, B. (ed.). 2007. Economics and market analysis of the live reef-fish trade in the Asia-Pacific region. *ACIAR Working Paper 64*, 173 pp. Australian Center for International Agricultural Research, Canberra.
- Josupeit, H. 2007. World market of tilapia. *Globefish* 79, 28 pp.
- Josupeit, H. 2007. Tilapia production and trade growing. *Eurofish Magazine* 1/2007, 104–107.

- Ko Lay, Khin.** 2006. Facts about fisheries. Ministry of Livestock and Fisheries: Department of Fisheries, Ministry of Livestock and Fisheries, 5 pp.
- Le, T.H., Huy, H.P.V., Truc, L.T.T. & Lazard, J.** 2006. Home-made feed or commercially formulated feed for *Pangasius* catfish culture in Viet Nam? Present status and future development. In *International symposium of nutrition and fish feeding*. Biarritz, France, 28 May–1 June 2006.
- Le, T.H., Truc, L.T.T. & Huy, H.P.V.** 2007. Case study on the use of farm-made feed versus commercially formulated feed for *pangasiid* catfish in the Mekong Delta, Viet Nam *FAO Fisheries Technical Paper* 497 (in press).
- Nandeesh, M.C.** 2006. Status of global and Indian aquaculture: opportunities for India to make greater contribution. *Indaqua 2007*, January, Souvenir MPEDA, Kochi, India, p.7–14.
- Na-Nakorn, U.** 2004. A perspective of breeding and genetics of walking catfish in Thailand. *Aquaculture Asia IX*, 23–28.
- Naylor, R.L., Goldburg, R.J., Mooney, H., Beveridge, M., Clay, J., Folke, C., Kautsky, N., Lubchenco, J., Primavera, J. & Williams, M.** 1998. Nature's subsidies to shrimp and salmon farming. *Science* 282, 883–884.
- Naylor, R.L., Goldburg, R.J., Primavera, J., Kautsky, N., Beveridge, M., Clay, J., Folke, C., Lubchenco, J., Mooney, H. & Troell, M.** 2000. Effect of aquaculture on world fish supplies. *Nature* 405, 1017–1024.
- Naylor, R.L., Williams, S.L. & Strong, D.R.** 2001. Aquaculture- a gateway for exotic species. *Science* 294, 1655–1666.
- New, M.** 1991. Compound feeds – world view. *Fish Farmer*, March/April 1991: 39– 46.
- New, M.** 1997. Aquaculture and the capture fisheries – balancing the scales. *World Aquaculture*, 28: 11–30.
- Ng, W.K., Soe, M. & Phone, H.** 2007. Aquafeeds in Myanmar: a change from farm-made to factory-made feeds. *Aquaculture Asia*, XII (3), 7–12.
- Nguyen, H. Dzung.** 2007. Progress in aquaculture development. *INFOFISH International* 2/2007, 9–11.
- Nguyen, Vo Hoang.** 2007. Viet Nam's catfish and marine shrimp production: an example of growth and sustainability. *Aquaculture Asia-Pacific*, 3 (4), 36–39.
- Pandey, M.R. & Chaturvedi, G.K.** 1984. Inland Fish Marketing, *Inland Fishery Resources in India*, (eds.) Srivastava, U.K. and S. Vasthala. Concept Publishing Company, New Delhi 564 pp.
- Sadovy, Y.J., Donaldson, T.J., Graham, T.R., McGilvary, F., Muldon, G.J. et al.** 2003. *While Stocks Las : The Live Reef Food Fish Trade*. Asian Development Bank, Manila, Philippines, 146 pp.
- Sahoo, K.N., Roy, A.K., Saradhi, K.P. & Saha, G.S.** 2001. A study on marketing channel of fish produce of Kolleru lake. *Journal of Fisheries Economics and Development*, Vol. V, No.1.
- Sim, Y. Sih.** 2006. Marine finfish market information and aquaculture development trends in selected locations in Indonesia and Malaysia. *Aquaculture Asia XI* (4), 18–21.
- Sinh,** 2007. Personal communication to author.
- Speedy, A.W.** 2003. Global production and consumption of animal source foods. *Journal of Nutrition*, 133, 4048S–4053S.
- Subasinghe, R.** 2006. State of world aquaculture: 2006. *FAO Fisheries Technical Paper* 500, 134 pp.
- Sugiyama, S., Staples, D. & Funge-Smith, S.** 2004. Status and potential of fisheries and aquaculture in Asia and the Pacific. RAP Publication 2004/25, FAO, Regional Office for Asia and the Pacific, Bangkok, 53 pp.
- Tunkijjanukij, S. & Intarachart, A.** 2007. Development of green mussel cultivation in Thailand: Sriracha Bay, Chonburi Province. *Aquaculture Asia XII* (2), 24–25.
- Veerina, S.S., Nandeesh, M.C., De Silva, S.S. & Ahmed, M.** 1999. An analysis of production factors in carp farming in Andhra Pradesh, India. *Aquaculture Research* 30, 805–814.
- Wan, H. & Wan, Y.** 2002. The model of ecological fisheries – integrated fish farming. *Inland Fisheries*, (12): 3.
- Win, Hla.** 2004. Opportunities and challenges in Myanmar aquaculture. *Aquaculture Asia IX* (2), 12–15.

PLATE 1
Stages of the carp marketing systems in Kolleru Lake area, Andhra Pradesh, India
(photos by courtesy of Dr Hari Babu)



Carp fingerling sale



Carp fingerling transport for stocking



Grading of a harvest



Packed and ready for loading into trucks for long distance transportation



Fish packed in thermo cool boxes



Truck being packed for transportation to destination

PLATE 2
Feed being replenished into a feed bag in a carp pond, Myanmar



PLATE 3
Stages in rohu "exports" from Myanmar



Harvest brought to the roadside



Fish (rohu) in ice brought to the plant



Gutting and cleaning



A back gutted rohu



Ready for glazing and freezing



Awaiting shipment

PLATE 4
Activities of the market chains of carp and catfish farming in Viet Nam



Typical carp fry to fingerling rearing facility in DakLak Province, Viet Nam



Packing of carp fry for transport of fry to fingerling rearing facilities far away



Fry are mostly transported on motorcycles



In the local markets carp are sold whole or in pieces



Catfish are cultured in very high densities and are fed intensely



Harvested catfish being loaded onto a boat for transport to the processing plant

PLATE 5

Stages in the market chain of cultured freshwater species, such as snakeheads and catfishes, Thailand



Vehicles transporting live fish from farms to the wholesale market



The market: hub of activity



Sorting of snakehead



Snakehead priced according to size



Catfish wholesaler



A common suburban market selling live snakehead

PLATE 6

Dried fish products, from wild caught fish often prepared on a household basis and a variety of fish sauces at a major processed fish products market, Lao People's Democratic Republic



ISBN 978-92-5-106070-4 ISSN 2070-6065



9 789251 060704

TR/D/I0329E/1/09.08/540