
Commercial aquaculture in Southeast Asia: Some policy lessons[☆]

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ABSTRACT

Globally aquaculture has been increasing rapidly and already accounts for nearly half of all food fish consumed. For developing countries, which produce 90% of the world's output, aquaculture is a source of protein, employment, income and of foreign exchange. Southeast Asia is an area which has experienced this "blue revolution". Total aquaculture output in the region increased from less than two million tonnes in 1990 to more than eight million tonnes in 2006. Moreover, the region's pace of expansion has accelerated. Annual average growth rates in output from 2000 to 2006 were more than double those from 1990 to 2000. Already more than a quarter of food fish in Southeast Asia comes from aquaculture.

Aquaculture matters because fish products are important in the diet of much of Southeast Asia. The population generally has a high per capita consumption of fish, and fish are a major source of animal protein in a region where levels of animal protein are below the world average. Output from the capture fisheries has increased but growth rates are slowing. To maintain present levels of per capita consumption of fish in the region, whose average population is projected to grow by 16% by 2015, requires continued expansion of aquaculture.

The paper focuses on commercial or profit-oriented aquaculture. It produces protein, but also rural employment and income. It also has the potential to generate taxes for governments and foreign exchange, and by improving economic efficiencies and competitiveness hold down the cost of aquatic products. Contributing to food security, rural livelihoods and economic growth, aquaculture is an important and growing sector in the region and merits study. It is hoped that lessons learnt can be useful to other parts of the world.

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Introduction

The growing importance of aquaculture as a source of food has been well documented in the literature (IFPRI, 2003; Wijkstrom, 2003). Aquaculture already produces nearly half of the world's food fish, and this share is forecast to increase. With more than 90% of all aquaculture output produced in the developing countries, its economic, nutritional and social impact is also likely to grow. Commercial aquaculture increases the supply (availability) of food and the demand (accessibility) for food, thereby enhancing food security (Hishamunda and Ridler, 2006). By providing employment, it directly generates income and, through linked activities, indirect employment. It contributes to tax revenues and perhaps also to the trade balance. Even if aquaculture is

marginal nationally, it may be important at a local level. An illustration is aquaculture in the Philippines where aquaculture employs only a very small proportion (less than 1%) of the total labour force of more than 27 million. However, in the municipality of Lake Sebu Mindanao, (tilapia) aquaculture contributes more than half the annual municipal income and employs ten per cent of the labour force (Philippines National Report, 2004). These positive benefits must be weighed against negative impacts, such as environmental damage or social unrest.

This paper examines policies that have been used in Southeast Asia to promote commercial aquaculture. Of the seven countries in Southeast Asia covered in this paper (Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Thailand and Vietnam), all but Cambodia, with its productive inland fisheries, ranked among the top 25 countries in terms of aquaculture volume according to the latest FAO statistics (FAO, 2008). Together, the seven countries earned more than 11 billion dollars from aquaculture in 2006. Excluding aquatic plants, this region accounted for 11% of world output. Over the last ten years, their combined output has doubled.

[☆] Opinions in this paper are the sole responsibility of the authors and do not necessarily reflect the views of any organisation including the FAO.

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The rapid expansion of aquaculture in the region and the variety of experiences provide an excellent opportunity to assess policies that enabled the sector to develop in some cases and constrained it in others. There have been a variety of policies due to topography, availability of coastline and land, openness to foreign markets and capital, and political upheavals. Commitment to aquaculture has also differed with little support in Cambodia but significant promotion in neighbouring Vietnam. Both are net fish exporters, but Cambodia has relied on its inland capture fisheries whereas Vietnam has promoted aquaculture as a source of foreign exchange and of economic development. Already the contribution of aquaculture to economic activity in Vietnam is one of the highest in the world. In countries where aquaculture is a priority some policies such as providing incentives to hatcheries and grow-out farms, attracting foreign investment into fish feed activities, have evidently been successful. There have also been failures (as with interest rate subsidies in the Philippines) and it is important to learn from these also. Such policy lessons should be useful to other countries. A further reason for studying the region is the damaging effect which coastal aquaculture has had on mangroves in several countries. Governments in the Philippines and Thailand which encouraged aquaculture in the 1960s and 1970s did not anticipate the destruction of mangroves, but they, like late-comers to the sector, have since implemented preventive regulations to protect coastal areas.

The first section briefly describes the main features of aquaculture in Southeast Asia, and its variation among countries. The second section analyzes policies that have eased production constraints (fish feed, seed and investment capital) impeding expansion of commercial aquaculture in the region. A final section examines regulations that enhance environmental sustainability.

Aquaculture in Southeast Asia

Total fisheries production includes output from both aquaculture and the capture fisheries, and more than tripled from 1980 to 2006 in the region. The capture fisheries remain the major source of fish production, but a growing source of food fish comes from aquaculture. From 10% of total fisheries production in Southeast Asia in 1980, aquaculture's share increased to 17% in 2000, and 27% in 2006. By 2006, therefore, more than a quarter of total production of food fish came from aquaculture.

Not all seven countries in the region are equally dependent on aquaculture. Table 1 below illustrates the relative role of aquaculture among the seven countries in the region. Cambodia and Malaysia have a small aquaculture sector relative to other countries, and also to their capture fisheries. In Cambodia, as in Myanmar, the inland fisheries are important and aquaculture is primarily a subsistence (rather than commercial) activity whose principal purpose is to provide food for farming families. This is reflected in their reliance on carp. Carp and undesignated fresh fish account for more than 85% of their total farmed output of food fish.

With the exception of Cambodia and Myanmar governments in the region have actively supported aquaculture whether prompted by concern for food security or for foreign exchange. Early-movers such as the Philippines and Thailand encouraged aquaculture in the 1960s and 1970s, because it provided livelihoods (milkfish culture in the Philippines) or earned foreign exchange (shrimp farming in Thailand). Livelihoods and foreign exchange continue to be the main motivators behind government support. Indonesia's intensification program aims to increase the intensification of species, such as tilapia (*niloticus*), shrimp, seaweed and grouper that are destined for foreign markets (Budiono, 2002). Malaysia's support for aquaculture also focuses on internationally traded fish. Malaysia has a food deficit and actively supports agriculture and aquaculture as a means of strengthening its balance of trade for Vietnam, aquaculture development is a national priority in economic development and is promoted both for its impact on livelihoods and for its foreign exchange potential (Vinh, 2006). The effectiveness of this commitment is shown by results; aquaculture volumes and values have doubled since 1995. In Thailand and Vietnam more than a third of their food fish comes from aquaculture, with Vietnam's aquaculture output being the largest and reflected in the share. Almost half of Vietnam's fish production comes from aquaculture.

Mariculture is the fastest growing aquaculture environment in the region and cage culture of marine fish offers considerable potential. Although expansion of certain species such as sea bass and grouper is limited by feed and seed availability, other species have seen output growth. An example is milkfish cultivation in the Philippines where cultivation in marine waters more than quadrupled between 2000 and 2006.

While the tonnage from aquaculture in the seven countries combined has consistently increased, there has been more variability with the value of output. In 2003 the value of aquaculture output, even with the inclusion of aquatic plants, was approximately the same as in the mid 1990s. The reason for the overall variability has been the declining value of aquaculture output in some countries, not always offset by increasing values in others. The value of aquaculture output from the Philippines was lower in 2006 than in 1994 (with or without including aquatic plants). Thailand has also seen revenue declines; it had fewer revenues in 2006 than in 2000. As in the Philippines, a major explanation for declines in aquaculture value was the collapse in revenue (and production) of shrimp due to diseases. On the other hand, other countries have seen sharp increases in aquaculture revenues. By 2006, Vietnam ranked first in the region in the value of aquaculture output, whereas in 2000 it was only third, and fourth in 1990. Vietnam earned more than three billion dollars from aquaculture in 2006 compared with less than a billion dollars in 2000. Another country that has experienced a sharp increase in the value of aquaculture output is Myanmar. Table 2 below illustrates these changes in aquaculture values from 1990 to 2006.

The importance of aquaculture as a source of domestic food is highlighted by the role of fish as animal protein. The region relies

Table 1
Relative importance of aquaculture in fish production by country, 2000–2006

Country	Total Fish Production (Tonnes)		Aquaculture (Tonnes)		Share of Aquaculture in Total Food Fish Production (%)	
	2000	2006	2000	2006	2000	2006
Cambodia	298,798	516,700	14,430	34,200	4.8	6.6
Indonesia	4,872,079	6,068,567	788,500	1,309,247	16.2	21.2
Malaysia	1,445,098	1,468,732	151,773	168,317	10.8	11.5
Myanmar	1,192,112	2,581,780	98,912	574,990	8.3	22.3
Philippines	2,292,905	2,945,091	393,863	623,369	17.2	21.2
Thailand	3,735,279	4,162,096	738,155	1,385,801	19.8	33.3
Vietnam	2,121,829	3,617,627	498,517	1,657,727	23.5	45.8
TOTAL 7	15,958,099	21,360,593	2,684,150	5,753,651	16.8	26.9

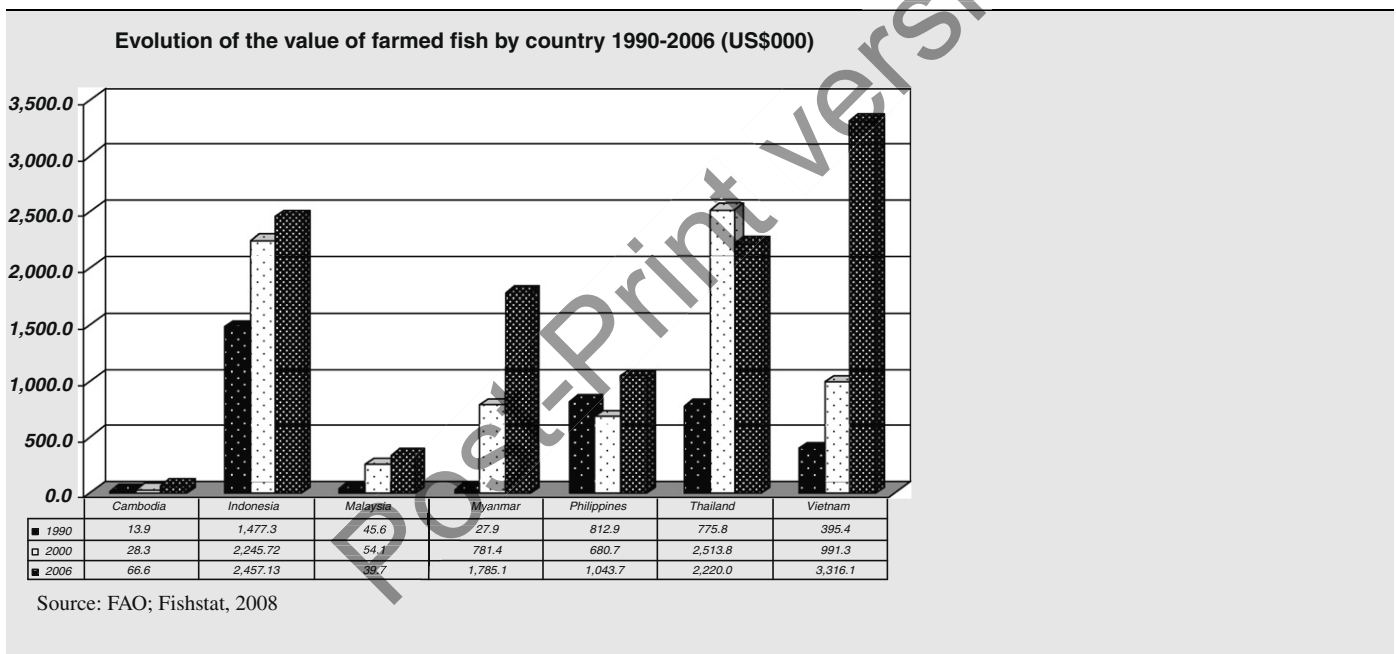
Source: FAO: FishStat, 2008.

heavily on fish for protein, and with the exception of shrimp, a high value species that is raised mainly for export, the other major species in the region (milkfish, the rohu, the common carp and tilapia) are farmed primarily for local consumption. Average per capita consumption of fish in all seven countries is higher than the world average of 16.1 kg a year. In Malaysia per capita consumption of fish is more than triple the world average; in Cambodia, the Philippines and Thailand it is also much higher. The high fish consumption is reflected in the share of fish in animal protein. Generally, the region has low levels of protein particularly animal protein, being only 87% of the world average of total protein and 67% of animal protein. Therefore, dependence on fish for nutrition becomes particularly important. Whereas fish accounts for 15% of total animal protein globally, it accounts for significantly more in all seven countries. The proportion of fish in animal protein is more than double the world average in all countries except for Vietnam. In Cambodia it is three times and in Indonesia four times the world average. Table 3 shows average fish consumption and fish protein intake, as well as the contribution of fish to animal protein intake.

Policies to promote aquaculture

In a recent Delphi survey on constraints and opportunities for aquaculture in Asia, a continued commitment towards aquaculture by government policy-makers was judged to be critical if the sector was going to continue to expand (Hishamunda et al., 2007). This commitment is illustrated in the length of leases which provide security to investors, and reassurance to lenders. Both the Philippines and Vietnam have used aquaculture leases to stimulate the sector. When the Philippines saw aquaculture as a means of increasing fish supply and of providing livelihoods for the poor, fishponds were given long leases, and once developed, these lands were titled and transferable (until 1972). Annual rent was low and land in fishponds was exempted from the comprehensive agrarian reform program designed to redistribute land. Similarly, Vietnam has shown its commitment by providing long (20–50 year) leases. Also officials are obliged to process aquaculture permits within 90 days of the application; otherwise the applicant has *de-facto* a permit.

Table 2



Source: FAO (2007).

Table 3
Some indicators of food insecurity 2003

	Population millions	Prevalance of under-nourishment % Of population	Per capita fish cons. (kgs/year)	Fish protein Grams/person/day	Animal protein Grams/person/day	Fish/animal proteins (%)	Fish/Total proteins
Cambodia	14.1	38	27.1	8.2	14.5	56.5	16.0
Indonesia	219.8	6	20.5	7.0	10.2	68.6	11.1
Malaysia	24.4	<3	55.9	15.2	39.8	38.2	20.3
Myanmar	49.4	7	18.9	5.3	11.7	45.2	6.6
Philippines		80.0	22	28.8	9.5	24.8	38.3
16.4							
Thailand	62.8	19	30.5	9.8	24.1	40.6	17.4
Vietnam	81.3	19	17.5	4.5	17.4	25.9	6.9
World	6,198.0	17	16.1	4.4	29.1	15.1	5.8

Sources: FAO (2006); The World Bank (2005).

In addition to government commitment, the experts in the Delhi study also listed constraints such as domestic fish feed, and access and cost of capital, as among the constraints that could “have a very large negative impact” on future development of aquaculture in Asia (Hishamunda et al., 2007). This is because government support by itself does not guarantee the success of aquaculture; an individual entrepreneur has to be willing to invest in a risky enterprise. These risks can be minimised by an enabling environment through good governance, but also by pro-active policies such as ensuring the availability of affordable fish feed and fish seed, and improving access to capital and markets.

Policies towards feed production

The availability and cost of feed can be a critical constraint to aquaculture. Lack of feed availability may be reflected in irregular feed supplies or shortages that add to risks jeopardizing operations; this has been a problem in Myanmar where border delays have led to spoilage. To circumvent delays sea freight is used, but it doubles the cost of delivered feed. In Cambodia there is the problem of seasonal availability of trash fish to feed carp.

In most Southeast Asian countries the supply of fish feed has developed according to market forces with few incentives. Feed plants that catered to livestock producers diversified from livestock to aquaculture feed as the industry developed. The result is a predominance of the private sectors in all countries except Cambodia. In Vietnam with its ambitious aquaculture plan that aims to double aquaculture output by 2013, the need to increase domestic capacity in feed has prompted it (and Myanmar) to encourage foreign direct investment in the feed sector. This jump-started the feed industry, and while fish feed in Vietnam is still mostly produced by foreign companies, domestic firms are taking a growing share of the market.

Where feed is a constraint, it is usually its high cost rather than availability. This is the case for shrimp feed for *P. monodon* in Indonesia and catfish *Pangasius* in Malaysia. Cost is important because feed is the major expense in cultivating most species. For all species except carp, feed costs far outweigh labour costs. Feed accounts for as much as 82% and 70% of total costs for tilapia (in ponds and cages, respectively), more than 50% for milkfish and seabass cage culture and for shrimp pond culture (Baliao et al., 2000; Ling et al., 2001). Only carp culture has very low feed expenses, because residuals from farms such as rice bran are used.

The high cost of feed is due to the need to import essential ingredients such as fish meal. The problem was exacerbated during the Asian crisis, when currencies depreciated causing the cost of imported ingredients to rise. To lower the cost of feed Indonesia and Malaysia are experimenting with local ingredients rather than imported fish meal (Subasinghe et al., 2002). In addition both countries (and the Philippines) are reducing costs by exempting imported ingredients from import taxes. Tariffs on imported feed and fish meal in the Philippines have fallen from 30% in 1981–1983 to 3% at present, forcing domestic feed companies to compete with international producers.

Policies towards seed production

A serious constraint for certain species is seed availability and quality. Catfish in Cambodia, milkfish and grouper in Indonesia, tilapia in Malaysia and the Philippines, and sea bass and grouper in Thailand and Vietnam where fry are collected from the wild, are among the species whose cultivation is constrained by seed. Shrimp farming is also handicapped by seed shortages in some countries such as Malaysia, Myanmar and Vietnam. In addition to seed shortages Vietnam also has regional imbalances in seed distribution, providing a transport subsidy for freshwater seed when

destined to remote and mountainous regions. Carp culture on the other hand, does not have a problem with seed (ADB-NACA, 1996). In addition to seed availability for certain species, the quality of seed is also an issue.

Countries in the region have had a similar approach to the supply of seed, particularly for freshwater species such as carp and tilapia if private hatcheries do not exist, or lack the capacity and that is the funding of public fish hatcheries. Policy-makers recognize that public hatcheries should encourage the cultivation of particular species, demonstrate hatchery technologies, and stock waterways.

Indonesia and Malaysia use their public hatcheries to enhance the cultivation of certain species; in Indonesia where the private sector predominates except with grouper, the public hatcheries provide broodstock to maintain quality. In Malaysia the six public hatcheries focus on production of seed that is ignored by the private hatcheries, or that are scarce (marine shrimp, giant freshwater prawn, mud crab sea bass and a number of freshwater fish). The purpose is to jump-start farming of certain species.

In Cambodia and the Philippines the public hatcheries concentrate on raising indigenous freshwater species to stock waterways or assist small-scale farmers. With tilapia in the Philippines government hatcheries are sometimes viewed negatively because they price fry much lower than market price (as much as 50% less) in order to encourage small-scale farming. Private hatcheries also complain that the fry are sold below industry standards, which in turn forces small-scale private hatcheries to lower their standards to remain competitive. In Vietnam where marine seed is a priority, a national marine development strategy has been developed in which the National Centre for Marine Seed provides broodstock for different hatcheries throughout the country and conducts research on marine seed. Government funds are also available to send students abroad to learn the technology of marine seed production.

In addition to these publicly funded fish stations, there has been an expansion of private hatcheries, sometimes competing with the public hatcheries. Incentives have been successful in encouraging private hatcheries and in most countries and for most species the private sector predominates. In Vietnam there is preferential credit for household farmers investing in shrimp hatcheries, and results have been impressive, even in the North where shrimp production is less developed. The number of hatcheries has increased sharply to almost 3000 (Vietnam National Report, 2004). For marine seed hatcheries can receive credit for five years, and no collateral is required except for very large loans. There are also tax exemptions for imported seed, broodstock, and material for hatcheries and farms. Foreign companies investing in marine seed production are eligible and are exempt from value added tax; they also enjoy reduced land taxes.

In addition to funding public hatcheries, and providing tax incentives to private hatcheries, other policies have been adopted in the region. A common problem in seed availability is poor linkage between seed producers and growers, and Indonesia and Thailand are attempting to improve communication. Indonesia has organised regular private/public seed markets to match hatcheries with farmers. Similarly, Thailand has developed information centres with a data base on hatcheries and species to connect seed producers and fish growers.

The quality of seed is also a policy issue in some countries. In freshwater aquaculture, where farms produce their own seed or buy from others, there is a danger of in-breeding without careful husbandry. In marine shrimp, the fry may be infected with viral diseases. Governments can assist with diagnostic services, research into new strains and with certification of hatcheries.

Seed quality is assured in Indonesia by a number of regulations. There are production standards as specified in Indonesian national

seed standards. There is also seed inspection with certification and monitoring. These measures appear to have been successful. In the Philippines, the Nile tilapia stock has been improved through a breeding programme that has had considerable international assistance. With the expertise of Central Luzon State University (CLSU) and foreign experts, the genetically improved farm tilapia (GIFT) has been developed. Producers of GIFT tilapia must pay a refundable cash bond and a royalty fee based on the number of fry produced per brood stock. In the Philippines and Vietnam, there is pressure to require the certification of shrimp hatcheries.

Policies towards investment capital

Six of the seven countries provide incentives for investment in aquaculture, whether as part of a broader strategy for food production, or as a policy specific to aquaculture. The exception is Cambodia. Loans may be given at a preferential rate (Indonesia and the Philippines), or access to loans made easier (all but Cambodia). In addition some countries offer tax holidays, targeting the incentives to the poor, or to certain regions.

The high cost of money is often cited as one of the factors retarding the growth of the industry. Two countries that have experimented with subsidising the cost of credit are Indonesia and the Philippines. In Indonesia the government since 2001 has provided credit for fixed and operating expenditures at 16%, with an interest rate subsidy if market rates exceed this. As with the Philippines the subsidy was oriented to small-scale farmers. However the Philippines found that subsidized interest rates benefited mostly the bigger borrowers rather than the targeted clientele, big borrowers often prevailing, because they had the collateral and were considered less risky. Also programs involving direct lending by government agencies generally ended up with poor repayment performances as a result of inferior fund management. These considerations therefore have forced the Philippines to abandon interest rate subsidies.

However, availability of credit may be more constraining than the cost of capital particularly for small-scale farms, due to stringent banking requirements such as the need for collateral and high equity. Credit from feed suppliers through deferred feed payments is often available in Southeast Asia and this is important, because feed is the major expense item in most aquaculture operations. However informal *de-facto* short-term financing from feed suppliers can only be accessed if the farmer has the physical facilities for culture in the first place, and it is typically in the initial stage of pond construction, and cage acquisition when access to credit is most needed.

Obviously there is a need for special loan program to address the need of those who do not have their own funds to acquire or develop culture facilities. In Indonesia the government requires private banks to transfer 1–5% of their profits to cooperatives and small-scale farmers as credit, thereby increasing availability of credit. It also has a policy to encourage small-scale producers of shrimp and tilapia through voluntary business partnerships. A large farm (nucleus) ensures the seed and feed production and also the marketing for small-scale farms that are distributed to the landless for their eventual ownership under an approved financing plan. The nucleus farm also provides credit and technical knowledge to these grow-out farms. The government's role has been to facilitate and monitor these partnerships and to suggest improvements. These small-scale farms are predominant in shrimp (60%) and particularly grouper and seaweed (100%) (Indonesian National Report, 2004).

Governments in other countries also provide start-up funds. Malaysia provides financing for food projects through its fund for food (3F) project and also funds small and medium sized agribusinesses. Loans without collateral targeted to small-scale farm-

ers have been successful in Malaysia, but where collateral is required as in Myanmar's incentives for carp farmers, start-up financing has been less effective.

Fiscal incentives are also offered. In Indonesia domestic and foreign entrepreneurs who are willing to invest in the eastern parts of Indonesia are eligible for tax holidays. Vietnam provides incentives for those who are interested in starting aquaculture providing land tax exemptions to commercial farmers faced by market risks. This is in addition to three year tax exemptions on income taxes for farmers who engage in aquaculture in non-productive land or lagoons

Funding for high risk operations such as aquaculture can also come from foreign investment. However foreign investment in aquaculture, particularly in new technologies, remains small in Southeast Asia: aquaculture development has relied largely on local, rather than foreign, entrepreneurs. Certain countries (i.e. Indonesia, Myanmar and Vietnam) offer fiscal incentives such as tax holidays or exemption from import duties to foreign investors in aquaculture. However, there are often limits to foreign ownership of natural resource based industries; in the Philippines such industries are reserved to nationals or to companies with 60% local ownership. In Vietnam foreign investors are allowed up to 70% share and in Myanmar where there is apparently no set ceiling on foreign ownership, foreign investment is allowed only for joint venture.

Environmental regulations

Up to the 1980s, governments in Southeast Asia were fairly liberal in granting permits to develop mangrove areas into aquaculture farms. In the Philippines mangrove swamps could be converted into fishponds (typically for milkfish) for 25 years (renewable) under the fishpond lease agreement. Similarly in the early 1970s, coastal public lands in Thailand, could either be purchased or leased for up to 30 years on a renewable basis. However, there were unintended consequences. In the Philippines, the liberal granting of up to 400 ha and later reduced to 250 ha maximum for corporations and 50 ha for individuals, resulted in having a lopsided distribution skewed towards large farms and led to speculative holdings). A second unintended consequence was the lack of intensification attributable to the land rent. The low land rent failed to reflect the opportunity cost of land, and provided no incentive for land intensification. Instead it encouraged farmers to get more land. A third consequence in both the Philippines and Thailand was mangrove destruction. Now less than a third of the original 400,000 ha of mangroves remain in the Philippines.

As a consequence pond constriction in mangrove areas is prohibited. In the Philippines there is a complete ban on converting mangroves into aquaculture or into any other use. Developers are required to leave a 40 m strip along rivers and banks of streams, which should remain forested, or if denuded, should be planted with appropriate species for riverbank protection. In Thailand farms already operating in mangrove areas can continue, but no new leases are available.

Countries which entered shrimp farming later have learnt from the experience of the Philippines and Thailand and have introduced preventive measures. In Indonesia, public lands, including mangrove areas, can either be leased or purchased from the government, but there is a complete ban on any further development on the island of Java. The use of coastal areas for shrimp farming is also forbidden on islands of less than 10,000 km². Although aquaculture in mangrove areas is allowed on other islands it must meet two major conditions. The first is to leave a 100-m belt of mangrove intact along the water line. This Green Belt restriction along the coast is to assist in mangrove preservation. Farms in permitted areas of 50 ha or more in brackish water, and for larger farms in

lakes and in marine waters require an Environmental Impact Assessment. The second requirement is for ventures larger than 50 ha to be developed along the nucleus-estate concept. Myanmar also has a green belt in mangrove areas above the waterline but in Vietnam the government has completely banned any further development of mangrove areas.

Conclusion

The region has a long history of aquaculture, but rapid expansion only started after 1975, when total output was still less than half a million tonnes. By 1987 the seven countries in the region had an output of one million tonnes, excluding aquatic plants. Each decade thereafter has seen a doubling of output, with output of food fish in 2005 exceeding five million tonnes. As a group the countries have significant coastal waters, technical capacity, low costs, markets for farmed species and governments with the ambition to promote aquaculture. It seems likely, therefore, that the region's absolute volume of aquaculture output, and its share, will continue to increase. It has species that are technically feasible and economically viable, and governments committed to the sector.

However, these attributes are not uniform among the seven countries. Cambodia has a limited coastline (435 km²) and limited technical capacity. As with Myanmar, there is neither recognition of economic growth as a motor for poverty reduction nor acceptance of the need for good governance, which is a pre-requisite for private investment. Commercial aquaculture, therefore, is unlikely to develop rapidly in these two countries. Other countries, however, have fully recognized the potential of commercial aquaculture to stimulate economic growth, alleviate poverty and contribute to their balance of payments. Moreover, they have learnt from past mistakes and are aware of the need for the development to be environmentally sustainable.

They have also adopted policies to reduce the risks involved with aquaculture. Incentives targeting income groups, regions or sectors for credit have been successful. Examples are Indonesia with a fraction of bank profits designated for low-income groups, Malaysia favouring the food sector and Vietnam with its regional orientation. In general, interest rate subsidies have negative efficiency and equity consequences and fiscal policies are more effective; they are also less costly to administer because income tax exemptions and land tax deductions do not require heavy monitoring. Tax exemptions, unlike interest rate subsidies, also require no direct outlay from the public purse. Finally, the easing or encouragement of foreign investment, and of foreign technical assistance, appears to have been a successful means of acquiring capital, and of knowledge. Limits can be placed on the degree of foreign control of natural resources, and capital and profit repatriation to firms that have operated for several years.

Aquaculture especially shrimp farming in Thailand, Indonesia and Vietnam, milkfish and tilapia in the Philippines, as well as more recent farming of basa and tra catfish in Vietnam, gained a quick head start because they were not restricted by environmental, food safety and certification compliances. When it became successful, and its expansion became rapid without order, problems of disease and other sustainability concerns caught up with it and governments scrambled to regulate. Making affordable and reliable the supply of seed and feed, provision of credit and access to market were indeed good and pro-active policies but management mechanisms to make density of cages and feeding less polluting, making introduction of species especially the import of seed and broodstock biosecure, getting the hatchery and culture systems less dependent on antibiotics, and making market information less asymmetrical also had major impacts on aquaculture development.

References

- ADB-NACA, 1996. Aquaculture sustainability and the environment. report on a regional study and workshop on aquaculture sustainability and the environment. Asian Development Bank and the Network of Aquaculture Centers in Asia-Pacific, Bangkok, Thailand.
- Baliao, D.D., de los Santos, M.A., Franco, N.M., Jamon, N.R.S., 2000. Net cage culture of tilapia in dams and small farm reservoirs. Aquaculture Extension Manual No. 30, SEAFDEC, Aquaculture Department Iloilo, Philippines.
- Budiono, A., 2002. Country report: Indonesia. In: Review of the State of World Aquaculture (Draft Copy) Inland Water Resources and Aquaculture Service Fishery Resource Division FAO Fisheries Department FAO Fisheries Circular No. 886, Rome, Italy, pp. 176–188; 130.
- FAO, 2006. Food Balance Sheets 2003, FAO, Rome.
- FAO, 2008. Fishstat, FAO, Rome.
- Hishamunda, N., Poulain, F., Ridler, N., 2007. An analysis of constraints and policies in aquaculture globally: a Delphi approach. In: Hiemstra, L. (Ed.), Aquaculture, Canada, pp. 94–97.
- Hishamunda, N., Ridler, N., 2006. Farming fish for profits: a small step towards food security in sub-Saharan Africa. Food Policy 31 (5), 401–414.
- IFPRI, 2003. Fish to 2020: supply and demand in changing markets. In: Delgado, C., Meijer, S., Rosegrant, M. (Eds.), International Food Policy Research (IFPRI), Washington, D.C.
- Indonesian National Report, 2004. FAO: FIPP (mimeo).
- Ling, Bith-Hong., Leung, PingSun., Yung, C. Shang., 2001. Behavior of price transmissions in vertically coordinated markets: the case of frozen black tiger shrimp (*Penaeus monodon*). In: Leung, Pingsun., Sharma, Khem R. (Eds), Economics and Management of Shrimp and Carp Farming in Asia: A Collection of Research Papers Based on the ADB/NACA Farm Performance Survey, Bangkok, Network of Aquaculture Centres in Asia-Pacific, p. 244.
- Philippines National Report, 2004. FAO: FIPP (mimeo).
- Subasinghe, R.P.D., Curry, S.E., McGladdery, D. Bartley., 2002. Recent technological innovations in aquaculture. In: Review of the State of World Aquaculture (Draft Copy) Inland Water Resources and Aquaculture Service Fishery Resource Division FAO Fisheries Department FAO Fisheries Circular No. 886, Rome, Italy, pp. 85–102; 130.
- The World Bank, 2005. Little Data Book. International Bank for Reconstruction and Development/World Bank, Washington, DC.
- Vietnam National Report, 2004. FAO: FIPP (mimeo).
- Vinh, Do T., 2006. Aquaculture in Vietnam: development perspectives. Development in Practice 16 (5), 498–502.
- Wijkstrom, U., 2003. Short and long term consumption of fish. Veterinary Research Communications 27 (Suppl.1), 461–468.