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Sirikul, Boonsong; Luanprida, Somsak; Chaiyakam, Kanit & Sriprasert, Revadee

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AQUACULTURE DEVELOPMENT IN THAILAND

**Boonsong Sirikul
Somsak Luanprida
Kanit Chaiyakam
Revadee Sriprasert**

Department of Fisheries
Bangkok, Thailand

ABSTRACT

Aquaculture practised in Thailand is in the form of pond culture and cage culture in freshwater, brackishwater and coastal areas. The main species cultured include freshwater prawns, brackishwater shrimp, cockles, mussels, and various freshwater and marine finfishes. There is good potential for increased production from freshwater, brackishwater and marine aquaculture. However, the 1983 production of 145 000 mt represents only about 6% of Thailand's total fish production and production in this subsector has fluctuated widely. It will be several years before aquaculture production will contribute substantially to total production. Nonetheless, the culture of high value species of shrimp and fish could contribute significantly to export earnings during the next 5 to 10 years.

Conducted primarily by government agencies, research and development are along the lines of increasing seed supply, establishing new culture techniques or improving older ones. The Department of Fisheries (DOF) together with some private companies have ventured into the development and testing of artificial diets for the various cultured species using a variety of indigenous feed stuffs.

It is estimated that with adequate investments and appropriate support, aquaculture production will increase from 145 000 mt in 1983 to 378 000 mt in 1991, showing an annual increase of about 13% over this period. Major increases would come from bivalve mariculture (131 000 mt), brackishwater ponds (36 000 mt) freshwater ponds (46 000 mt) and brackishwater cage culture (20 000 mt).

PRODUCTION AND DEMAND FOR FISH AND FISH PRODUCTS

Fisheries form an important industry in Thailand. Total fish productions in 1982 and 1983 were 2.1 million mt and 2.3 million mt valued at US \$857 million and US \$916 million, respectively. In terms of gross domestic product the fisheries sector contributed 1.7% in 1982 and 1.6% in 1983. Fisheries is one of the largest foreign exchange earners with export revenue at US \$517 million in 1982 and US \$551 million in 1983.

Inland Capture Fisheries

Inland capture fisheries has shown slow growth during the past several years. Although production data for this subsector may be inadequate, there are some indications that catch is declining. Continued effort by the Department of Fisheries (DOF) to stock fish and to conserve freshwater fishery resources is required to maintain production at 100 000 mt annually.

Aquaculture

Aquaculture in both fresh water and brackish water is practiced as pond and cage culture and along the coast as mariculture. The main species cultured are brackishwater shrimp, freshwater prawns, cockles, mussels, and various marine and freshwater fish species. There is good potential for increased production in aquaculture. However, the 1983 production of 145 000 mt represents only about 6% of Thailand's total fish production, and production in this subsector has fluctuated widely. It will take several years before aquaculture production can contribute substantially to total landings. Nonetheless, the culture of high-value species of shrimp and fish could contribute significantly to export earnings within the next 5 to 10 years.

With adequate investment and appropriate support, it is estimated that aquaculture production will increase from 145 000 mt in 1983 to 378 000 mt in 1991, an annual increase of about 13% over the present volume. Major increases would come from bivalve mariculture (131 000 mt), brackishwater pond culture (36 000 mt), freshwater pond culture (46 000 mt) and brackishwater cage culture (20 000 mt).

The projected demand for table fish for local consumption is presented in Table 1. Although this is based on a steady increase in demand, actually demand will continue to fluctuate as in the past, particularly in response to climatic factors and variation in the rate of growth of real income. There is no evidence of any long-term shift in underlying demand (i.e., a change in consumers' preference for fish) although it is possible that taste may shift in favor of poultry and red meats as supplies increase.

Table 1. Projected demand for table fish for local consumption 1983-1991 (Minimum estimate)

		Consumption per capita (kg)	Table fish demand	
			+ 2% (^{'000} mt)	+ 3% (^{'000} mt)
Base period	198-83	20.0	970	970
Required	1983 ^a		990	1000
	1984		1010	1031
	1985		1030	1060
	1986		1050	1090
	1987		1070	1120
	1988		1090	1160
	1989		1110	1190
	1990		1140	1230
	1991		1160	1270

a/ Preliminary estimate of apparent consumption is 1 059 000 mt.

PRESENT STATUS OF AQUACULTURE

Freshwater

Latest data indicate that the culture of freshwater finfish in Thailand primarily occurs in about 6000 ha of ponds and 53 000 ha of abandoned rice paddies. Finfish is also cultured in cages suspended in rivers and reservoirs. The yield varies with species and culture system. In ponds it is 1.2-120 mt/ha/yr and in paddies about 1.4 mt/ha/yr. Production from cage culture is 1-2 mt/yr/cage area of 20 m². The principal species cultivated with their corresponding culture systems and yields are shown in Table 2.

Table 2. Principal culture systems of freshwater finfish in Thailand

Species	Culture system M = Monoculture P = Polyculture	Stocking Rate (m ²)	Rearing time Per Crop (mo)	Yield (mt/yr)
<i>Tilapia nilotica</i>	Pond:			
	M or P, fertilized water	3	6	4.8/ha
	M, supplemental feed	3	4-6	6.2/ha
	M, integrated farming	3	4-6	7.2/ha
Carps (common Chinese, Indian)	Pond:			
	M, supplemental feed	0.7	12	1.2-3.6/ha
	P, fertilized water	0.7	12	1.2-2.4/ha
	M or P, integrated farming	0.7	12	4.8/ha
<i>Puntius gonionotus</i>	Pond:			
	M, fertilized water	3-4	6	2.4-4.8kg/ha
	M, supplemental feed	3-4	6	4.8-6.0/ha
	Paddy fields:			
	P	--	12	3-4 kg/ha
<i>Clarias</i> spp.	Pond:			
	M, complete feed	40-100	3.5-5	30-120/ha
<i>Ophiocephalus</i> sp.	Pond:			
	M, complete feed	30-40	8	90/ha
<i>Trichogaster</i> sp.	Paddy fields:			
	M, fertilized water	—	12	0.9-1.4*/ha
<i>Pangasius</i> sp.	Pond:			
	M, complete feed	3	12	30/ha
	Cage:			
	M, complete food	20	12	30 kg/m ² /crop
<i>Oxyleotris</i> sp.	Cage:			
	M, complete feed	100	15	35 kg/m ² /crop

*Includes about 0.5 mt of "wild" fish trapped in ponds and harvested with *Trichogaster* sp.

The *Macrobrachium* culture is growing rapidly in Thailand. Annual production exceeds 3000 mt in 1984 from more than 200 farms ranging in size from 800 m² to 40 ha. Average yield is 1000 kg/ha.

Brackishwater

The production of fish through aquaculture has recently acquired significance in Southeast Asia.

Attention is now being focused on the coastal environment primarily because saline and brackishwater have limited use for agriculture but can be used for aquaculture. There are several marine species of economic importance used for coastal aquaculture. Production from fisheries activities in a year was more than 2 million mt: 171 000 mt from aquaculture, 1 900 000 mt from marine fisheries, and 200 000 mt from freshwater fisheries. Aquaculture production is about 8.6% of the total.

The status of coastal aquaculture and mariculture can be seen in the production data in Table 3. Finfish from culture activities is not included as a separate category in official statistics.

Table 3. Production (metric ton) and value (x 1,000 Bahts*) of coastal aquaculture products

Year	Shrimp		Cockle**		Mussel		Oyster	
	Product	Value	Product	Value	Product	Value	Product	Value
1979	4 064	460 586	23 741	61727	49 397	65 698	9 876	91 452
1980	8 063	458 908	17 666	77 735	31 386	129 633	6 015	60 105
1981	10 728	657 264	23 354	81 373	36 746	78 469	8 429	85 951
1982	10 091	765 683	8 636	29 302	65 509	128 263	5 671	39 598
1983	11 550	950 370	16 575	56 095	43 130	106 983	5 322	38 669

* 30 Bahts = US \$11.10

* Includes Hoy Krang, hairy cockle, *Scapharca inequivalvis*

STATUS OF PRODUCTION TECHNIQUE

Finfish Culture

The culture systems for various finfish species of greatest economic importance are described below.

Clarias culture. The culture of *Clarias batrachus* and *C. macrocephalus* is well established in Thailand. More than 5 000 mt of *Clarias* valued at more than \$50 million is being produced annually.

Stocking rates of 3-7 cm fingerlings is 60-300/ m². The feed input is a mixture of 9 parts trash fish and 1 part of rice by-products. Marketable fish, 100-350 g, are attained in 3-5 months; most yields are 3-12 kg/m² of pond area depending primarily on mortality.

Management practices include liming the ponds to ensure suitable water quality, changing water when necessary, disease control and prevention by using formalin and dipterex to get rid of ectoparasites, and applying antibiotics in feeds to control or prevent bacterial diseases.

High fish mortality are often related to poor water quality due to contaminants. Increasing cost of feeds and unstable market prices are prevailing problems of the industry.

Sepat Siam (*Trichogaster pectoralis*) *culture.* *Trichogaster* is primarily cultured in abandoned paddy fields modified to form 5 ha ponds by constructing a peripheral ditch and an enlarged dike to maintain water depth greater than what is necessary for rice production. Returns from this culture system are more profitable than rice cropping. Present annual production is in excess of 13 000 mt in 1984 valued at \$20 million.

The stock comes from brood fish introduced into the ponds. One pair of spawners is stocked per 16 m² of water surface. Resulting fry densities are about 185/ m². Emergent vegetation in the shallow central part of the pond is mowed regularly to enrich the water. Water exchange is practised. Fish are harvested when they reach about 100 g in 6-7 months. Yields of *Trichogaster* are usually 0.7-1.1 mt/ha; another 0.3-0.6 mt are obtained from wild fish (e.g., *Ophiocephalus*, *Anabas*, *Clarias*, etc.) which accidentally enter the ponds and are harvested along with *Trichogaster*.

Pangasius spp. cage culture. Commercial scale culture of *Pangasius* in cages is well established. The present yield is about 9000 mt. In 1984 market prices fluctuated widely and the value of this crop ranged from \$1.5 to \$3 million.

Cages, mostly 20 m^3 , are made of wooden slats usually attached to floating family dwellings. Fingerlings, 8-10 cm, are stocked at $50/\text{m}^3$ of cage volume. Basic feed consists, of rice bran, broken rice and trash fish mixed at a ratio of 9:1:1, respectively. Additional feed are soya bean and vegetable wastes. The typical feeding rate is 2% or less of the body weight daily. Mortality in cages is low and the normal yield is about $100 \text{ kg}/\text{m}^3$ for a 15-month growing period.

Sea bass (Lates calcarifer) culture. Seabass has been produced for more than 40 years in shrimp ponds in the coastal areas of Thailand. The method involved collection of sea bass fry from estuaries near the river mouth, mangrove areas, and from shrimp farms. The major problem was lack of fry for stocking which limited the expansion of culture areas. In 1973, the Department of Fisheries succeeded in artificially spawning sea bass. With sufficient fry available, the Department developed culture systems. Cage culture was demonstrated to be effective. Following the Department of Fisheries, the private sector also engaged in commercial breeding and culture of sea bass.

During the last decade the Department of Fisheries succeeded in establishing different techniques for producing sea bass fry:

1. *Natural breeding.* Usually 12-15 pairs of breeders are stocked per 150 t breeding tank. Breeding pairs are about 3 years old.
2. *Hormone injection.* The method was established at Prachuap Khiri Khan Station and is being used by many private farms.

The Fisheries Department can produce more than 30 million fry/yr. After 30-45 days, when the fry are approximately 1-1.5 cm in total length (TL) they are distributed to farmers. The fry can be cultured in brackish or freshwater areas. The culture techniques for sea bass are:

1. *Earthen pond culture.* Fingerlings, 2-3 inches long (50-100/pc), are stocked in ponds. Production period is 6 months to produce 2500 kg/ha.
2. *Cage culture.* Technique is commonly used in the southern and eastern coast of the coastal area. Two cage dimensions are used, namely, $10 \times 10 \times 2 \text{ m}$ and $5 \times 5 \times 2 \text{ m}$. Average production is $21.8 \text{ kg}/\text{m}^2/\text{yr}$. Stocking density is $25/\text{m}^2$ and harvest weight is 500 g. There are at present about 100 sea bass cages in Thailand (Table 4).

Table 4. Sea bass culture in Thailand as of 1983

Province	Rearing Facilities		Surface area	Rearing Facilities		Surface area	Production	Value
	pond	cages	(m ²)	farm	cages	(m ²)	(mt)	(× 1000 Baht)
Chanthaburi	3	4	188	3	4	188	3.48	231.37
Trat	1	3	24					
Krabi	2	3	27	2	3	27	0.42	33.60
Trang	42	77	816	16	20	480	9.17	634.37
Pattani	62	87	235	21	31	835	5.00	349.86
Phangnga	62	284	455	62	284	2445	169.58	13 107.63
Thatthalung	27	70	1827	16	56	1477	1.69	118.26
Ranong	4	15	4136					
Songkhla	363	845	40 527	355	848	39 161	784.28	58 368.78
Total	566	1408		475	1246	44 613	973.62	72 843.87

3. *Pen culture.* This system is not popular in Thailand because of the difficulty in finding suitable production areas.

Thailand is well known throughout Southeast Asia for sea bass. Large numbers of seed are exported to Hong Kong, Singapore, and Taiwan.

Grouper (Epinephelus spp.) culture. Grouper is a popular food fish in Southeast Asia. The fish can be cultured in ponds or cages. It grows fast to marketable size of 400-900 g.

The Department of Fisheries succeeded in artificial breeding of grouper by hormone injection in 1981. Other methods of breeding are natural spawning and stripping. In the latter, eggs are fertilized after the dry method. The fry are reared in a net-cage and fed with chopped fish until they reach 5-8 cm. After attaining the desired size, the fingerlings are transferred to a net-cage $3 \times 3 \times 2$ m or $5 \times 5 \times 2$ m at 25 fish/m². The stock is fed with trash fish until the fish weighs 400-500 g. The culture period is usually 6-7 months. Production is 25 kg/m²/yr.

Cage culture of grouper is practised throughout southern Thailand. There are about 900 cages in the coastal zones. The Department of Fisheries is conducting research on rearing of the larvae to metamorphosis. After the techniques have been established, the technology will be transferred to the private sector. Grouper culture in Thailand is presented in Table 5.

Feed development. A variety of feeds is used in freshwater aquaculture in Thailand. Growth of natural food is often enhanced with organic and sometimes inorganic fertilizers. Rice by-products such as rice bran and broken rice is commonly used as supplemental feed. Trash fish is the primary food for carnivorous species such as *Clarias* and *Ophiocephalus*. The use of artificial diets is gaining momentum with some commercial companies now producing specific feeds. The following diets have been developed by the DOF.

1. Feed formula for Carp and Tilapia broodstock
(Protein = 26%)

Fishmeal	18%
Peanut meal	26%

Table 5. Grouper culture in Thailand as of 1983

	Rearing Facilities		Surface area		Rearing Facilities		Surface area		Production		Value	
	pond	cages	(m ²)	area	farm	cages	(m ²)	area	(mt)	(× 1000 Baht)		
Chanthaburi	1	4	12									
Krabi	67	393	3738		25	225	2025		17.80		1 553.13	
Trang	9	38	955									
Phangnga	168	611	5433		152	564	5020		157.59		14 344.04	

Fine rice bran	30%
Cassava root meal	20%
Horse tamarind meal	4%
Vitamin & Mineral	2%

100%

2. Feed formula for carp fry (Protein = 33%)

Fishmeal	30%
Fine rice bran	45%
Peanut meal	24%
Vitamin & Mineral	1%

100%

3. Feed formula for growing tilapia (Protein = 18%)

Fishmeal	18%
Cassava root meal	41%
Fine rice bran	40%
Vitamin & Mineral	1%

100%

4. Feed formula for growing *Puntius* (Protein = 23%)

Fishmeal	12%
Peanut meal	23%
Fine rice bran	40%
Cassava root meal	20%
Horse tamarind meal	4%
Vitamin & Mineral	1%

100%

5. Feed formula for *Clarias* fry (Protein = 36%)

Fishmeal	60%
Peanut meal	8%
Fine rice bran	8%
Alpha starch	16%
Fish oil	6%
Vitamin & Mineral	2%

100%

6. Feed formula for growing *Clarias* (Protein = 32%0)

Fish meal	20%
Peanut meal	14%
Cottonseed meal	16%
Caproc seed meal	10%
Shrimp head meal	10%
Fine rice bran	10%
Cassava root meal	9%
Bone meal	2%
Horse tamarind meal	4%
Fish oil	3%
Vitamin & Mineral	2%
	100%

Seed production. Some seed for culture operations is provided by government hatcheries and many are generated by the farmers themselves. Fry and fingerlings of some species like *Clarias*, *Trichogaster*, and *Tilapia* are produced by brood fish reared in ponds with some special provisions. *Ophiocephalus* fry are obtained from wild sources. Seeds of certain species are obtained mainly through controlled reproduction by hormone injection. Hormone treatment varies depending on species.

Shrimp and Prawn Culture

Macrobrachium rosenbergii culture. The annual production of 3 100 mt in 1984 of *Macrobrachium* is valued at \$17.5 million. Some farmers grow their own seed stock in hatcheries ranging from backyard operations production with a few thousand larvae to industrial operations with an output of 10 million larvae. Current postlarvae supply is about 30 million/yr with 6 million originating from government hatcheries. Larval diets consist of egg custard and minced fish fed several times a day and *Artemia* nauplii fed once every evening. Grow-out prawns are fed a variety of diets ranging from farm-produced moist pellets to commercial poultry pellets. Feed conversion of the wet diets averages 1:6-7. Stocking density varies from 5-20/m².

Harvesting usually begins on the fifth month when the thinning out process starts and larger prawns are sold. The optimum market weight is 75 g each. The crop is harvested in about 8 months.

Total yield per ha is often less than 1 000 kg/yr. Survival can be as low as 20-40%, particularly when high stocking rates are employed. The low recovery is attributed to predation by crabs, carnivorous fishes, turtles, and poachers. Pond water is not normally renewed continuously but some larger farms replace 20% of the water daily.

Shrimp (*Penaeus monodon*, *P. merguensis*) *culture*. Shrimps are produced in earthen ponds. In most areas the traditional or extensive method of production is used. Methods are normally simple, land is subject to flooding at high tide and wooden sluice gates are installed to control water flow. Excavation is limited to a perimeter area yielding just enough material to make a narrow dike. Fry are allowed to enter the ponds with the incoming tide. They stay in the ponds for some time growing in the rich condition of the swamp. Average yield of *P. monodon* is 3750 kg/ha/year. The existing and potential

Table 6. Existing and potential shrimp farming area in Thailand as of 1983 (Coastal Zone Survey, 1983)

Province	Existing (ha)	Farms	Potential (ha)
Bangkok	881	141	
Samut Sakhon	2321	1039	
Samut Songkhram	5057	527	480
Phetchaburi	1211	106	640
Prachuap Khiri Khan	358	63	280
Chumphon	88	8	600
Surat Thani	1592	233	3200
Nakhon Si Thammarat	8658	1735	4800
Songkhla	58	9	240
Pattani	16	1	2560
Narathiwat	8	10	184
Trat	8	9	3200
Chanthaburi	548	62	480
Rayong	7	5	176
Chon Buri	544	56	320
Chachoengsoa	681	42	480
Samut Prakan	7841	985	160
Ranong	11	10	576
Phuket	—	—	32
Phangnga	99	10	720
Krabi	16	6	352
Trang	1	1	1040
Satun	256	3	640
Total	36 905	5334	23 160

areas for shrimp culture are listed in Table 6 and production from shrimp farming is shown in Table 7.

Table 7. Shrimp production in Thailand (Fisheries Statistics, 1986)

Year	Area (ha)	Quantity (mt)	Value (million baht)
1979	24 675	1 706 407	460.59
1980	26 036	706 305	458.91
1981	27 459	1 072 787	657.26
1982	30 790	1 009 077	765.68
1983	35 537	1 154 985	950.27
1984	36 792	1 200 675	1 024.01
1985	40 769	1 584 956	1 348.42

Table 8. Production in millions of brackishwater shrimp seeds for 1982-1986

Year	1982	1983	1984	1985	1986
Banana Shrimp	11 000	11 700	14 200	15 800	18 500
Jumbo Tiger Prawn	10 200	12 700	19 400	20 600	21 900
Total	21 200	24 400	33 600	36 400	40 040

Hatchery seed production of *Penaeus monodon* does not meet the demand. Production in 1984 was only 18.8 million postlarvae but demand was over 180 million. Insufficient seed supply is attributed to shortage of gravid females from the wild. Intensive research on broodstock development using eyestalk ablation has been conducted by the Brackishwater Fisheries Division. The Department of Fisheries is increasing the number of stations providing fry and is extending technological information to private investors to increase seed supply. The target production for shrimp seeds in government hatcheries for 1982-1986 is shown in Table 8.

Mollusc Culture.

Oyster culture. There are 4 species of oysters found in the coastal waters of Thailand. The important species for culture are *Saccostrea*

cucullata, *Crassostrea belcheri*, and *Crassostrea lugubris*. The former is distributed along the river mouths and coastal areas of Trat, Chanthaburi, Rayong, Chonburi and Prachuap Khiri Khan Provinces while the latter are found in Krabi, Phangnga, Surat Thani, Pattani and Chumphon. Oyster culture has existed in Thailand for more than 40 years. Several traditional methods have been practised depending on the nature of the substratum. Stones, stakes, or concrete blocks are used as substrates for attachment of oysters. Oyster seeds are small organisms generally suspended in the water. Pairoj (1974) conducted an experiment with *Crassostrea lugubris* on concrete culvert material. The oyster was harvested within 7-12 months. Yield was 250 000-312 500 oysters/ha. The yield of the small oyster (*S. cucullata*) culture in Chantaburi Province was 19 mt/ha.

At present, oyster culture area is approximately 1127 ha (Table 9), while the potential area for development is nearly 6400 ha (Table 10). Recent production figures are 5663, 8442 and 5171 mt for 1980 to 1982.

Mussel culture. Culture of the green mussel has been carried out in Thailand for more than 60 years. The fishermen first collected mussels attached to the stakes of certain types of stationary fishing gear. It was relatively easy to use strong lengths of bamboo or date palm stakes driven into muddy bottoms of shallow water zones as collectors of mussel spats. The method is commonly and successfully used along the coastal areas of Thailand. The attached spats are allowed to grow for 6-8 months before harvesting them for the market. Pairoj (1971) reported that yield of about 62.5 mt/ha could be obtained.

It is believed that the first mussel farming in the south began in Chumphon Province about 16 years ago. Promotion and extension of mussel farming were slow because of lack of natural seed in the coastal areas . of Nakhorn Sri Thammarat, Pattani, Surathani, and Phangnga. The Department of Fisheries introduced adult male and female mussels into other areas. The first introduction was in 1977 at Pattani. Later, mussels were transplanted to Nakorn Sri Thammarat and Phangnga. The results of these attempts have been moderately successful.

At present, mussel farms occupy 661 ha while the potential area is estimated to be 10 605 ha for the 21 maritime provinces (Tables 9 &

10). The production of green mussel is almost entirely from culture activities.

Table 9. Existing bivalve farm (ha) as of 1983

Province	Green mussel	Horse mussel	Blood cockle	Oyster	Total
Samut Sakhorn					
Samut Songkhram			320		320
Chachoengsao	240				240
Chon Buri	224	240		274	738
Rayong				83	83
Chanthaburi				467	467
Phetchaburi	48		128		176
Prachuap Khiri Khan	12			3	15
Chumphon	119			86	205
Surat Thani			160	79	239
Nakhorn Sri Thammarat			37		37
Phatthalung					0
Songkhla					0.16
Pattani	5				37
Narathiwat					0
Ranong				100	100
Phangnga	11		245	0.16	96
Krabi				2	1.6
Trang			16		16
Satun			300		300
Phuket					0
TOTAL	659	240	1206	1127	3232

Horse mussel culture. The two economically important species of the horse mussel found in Thailand are *Modiolus metcalfei* (Hanley) and *Arcuatuala arcuala*. Culture of these species have been conducted for more than 30 years. There were 117 ha of farming area in 1973. This was increased to 146 ha in 1978. Other species are found on the coast of Andaman Sea in smaller quantities.

Two methods of farming are usually employed. First horse mussel seed 5-10 mm in size are spread over the mud flat at a rate of 56-62/ha. After 8-12 months at the size of 2-3 cm the mussel are harvested by dredging. Production ranges widely at 75-225 mt/ha. In the second method, mussels are spread over the bottom of shrimp ponds. No data on yield/unit area are available.

The horse mussel, 2-3 cm in length, are sold for human consumption at 1.4 baht/kg. Smaller horse mussel are harvested and sold for animal feed at 0.75 baht/kg.

The potential area for horse mussel production is over 4500 hectares.

Table 10. Potential bivalve area (in ha) as of 1983

Province	POTENTIAL AREA					Grand Total
	Green Mussel	Horse Mussel	Blood Cockle	Oyster	Total	
Samut Sakhorn	320	96	320		736	736
Samut Songkhram	640		528		1168	1488
Chachoengsao	800	480	192		1472	1712
Chon Buri	320	320	80	160	880	1532
Rayong	640	160	80	240	1120	1203
Chanthaburi	575			480	1056	1523
Phetchaburi	320		532	160	1012	1188
Prachuap Khiri Khan	640	80	160	320	1200	1215
Chumphon	608	160	200	150	1118	1324
Surat Thani	640	200	2880	90	3970	4209
Nakhon Sri Thammarat						
Thammarat	1000	300	2272	140	3872	3909
Phatthalung						
Songkhla	160			80	248	248
Pattani	320		320	400	1040	1077
Narathiwat				500	500	500
Ranong	480	500	2000	500	3480	3580
Phangnga	960	2000	2000	1000	5960	6216
Krabi	480	160	752	201	1591	1595
Trang	400		1056	500	1956	1972
Satun	480	150	1000	500	2140	2440
Phuket	160		96		256	256
TOTAL	9944	4616	1447	5749	34 777	37 923

Cockle culture. Cockle farming has been conducted in Thailand for many years with the early farms located in Phetchaburi Province. In that area, approximately 50 cm high bamboo sticks are used to fence each production area which averages 1 ha. Farms are located in mud flats or shore lines and adjacent to river mouth or canal. The site must be intertidal, have sufficient width, and a small gradient.

Cockle seeds are collected from the wild in the same location. The prevailing species is *Anadara nofidera*.

During the last decade a different culture system has developed in the southern provinces, on the Andaman Sea Coast, and the Gulf of Thailand. Production is on mud flat with water depth of 2-5 m. Farm size is 32-320 ha. Farms require a large amount of seed for stocking. More than 4000 mt of cockle seed *Anadara granosa* are imported from Malaysia annually. This is stocked at 3375-6750 kg/ha. The seeds are dredged after a certain growth period to spread them evenly. The market size cockles are harvested after 12-18 months. The culture period depends on initial size of seed.

Seaweed Culture

Thailand does not produce large quantities of seaweed. Harvest is from natural beds. The Department of Fisheries is conducting research and examining the feasibility of mass propagation of seaweed species, especially *Gracilaria* sp. This species of algae is found in Trat, Songkhla, Pattani, and Trang Provinces. Local fishermen collect the seaweed and dry it for sale to middlemen for export. The price is about 20 baht/kg (approximately US \$1.10). Total export in 1982 was 68 mt valued at 21 thousand baht.

Laver (*Porphyra* sp.) is collected from natural areas during the cool season (December-January) principally from Songkhla Province. Production is very limited, amounting to only 100-300 kg annually.

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