



## **Snakehead Culture and its Socio-Economics in Thailand**

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## **INTRODUCTION**

Snakehead Channa striatus Fowler is the most widely distributed, economically important member of the genus. Distribution ranges from China to India, Ceylon and Southeast

Asia, in rivers, lakes, swamps, marshes, canals and ponds. In Thailand it is found throughout the country, except in the mountain region, (Smith 1945). It is one of the most common staple food fish in Thailand and other parts of Southeast Asia and regarded by the Chinese as a food fish for healing wounds.

Culture of Snakehead has been in practice in Thailand for about 10 years in the central and eastern parts of the country. Culture has expanded rapidly in the last five years, replacing Clarias (Catfish) farming as a result of the latter's disease problems and fluctuating prices. Estimates made in 1981 by Fisheries Statistics Section, Department of Fisheries, Ministry of Agriculture and Cooperatives indicated annual pond culture production of 7,255.56 tons valued at 244,396,060 baht (21.5 baht= 1 U.S.\$ in 1981).

## **BIOLOGY**

**Feeding habits:** In nature Snakehead is a voracious carnivore feeding mainly on live animals. Small fry-feed mainly on zooplankton and insect larvae, while larger fry and fingerlings commonly feed on invertebrates, frogs and smaller fish (Menon and Chacho 1958). The complete digestion of fish in the stomach takes 12 hours (Jaiyen 1977).

**Reproduction:** Snakehead is a nest-breeding species. The nest is prepared by the parent fish by clearing an area at the water surface of aquatic and emergent vegetation. This is done by biting off the weeds in shallow water near the edge of the water body. The fertilized eggs form a thin film at the water surface and are guarded closely by the male parent until they hatch and school break. The eggs are yellowish in color, 1.2 – 1.5 mm in diameter, having a large oil globule, floating to the surface and hatch in 24–35 hours at 28–30°C (Tongsanga 1960).

Under culture in the aquarium Snakehead matures in one year, measuring about 21 cm in total length. Breeding season of the fish in Thailand usually commences in April at the onset of the rainy season and extends to October, with a peak in June and August.

**Growth:** In nature Snakehead can attain a length of one meter. Size of 60–70 cm are very common (Smith 1945). In areas where fishing pressure is high the fish commonly found in natural waters are below 30 cm in length. On the day of hatching the larvae are 3.0–4.5 mm long, dark brown in color. Two days after hatching, fry start to swim vertically with right side up. Orange pigment develops on the fourth day and becomes a red-orange band along the body by day ten. At the end of the fourth week, the fry reach 2.4 – 2.6 cm in length and are dark gray in color and thereafter assume the habits of the adult. (Tongsanga 1960).

The Snakehead shows a much better growth rate under culture. With proper feed and stocking density, the fish commonly attain 300–500 gm in 9 months and 500–800 gm in 11 months.

With air breathing apparatus, the Snakehead is tolerant of water lacking in dissolved oxygen and can survive without water for a number of months as long as the skin and

breathing apparatus are kept moist. The fish can live in water having pH values of 4–5, with desirable range of 6.5–8.5. Positive growth occurs between water temperatures 28–35°C, where as optimum temperature is 30–32°C (Smith 1945).

## **CULTURE SYSTEMS**

Snakehead is cultured in a monoculture system. The culture operation is very intensive with continuous gravity flow of water if the farm is adjacent to an irrigation canal or daily water exchange by pumping from a canal or river into the pond, 2–4 hours a day. Normally pond size ranges from 800–1000 m<sup>2</sup> and 200–400 m<sup>2</sup> in Suphanburi and Samut Songkhram respectively. The optimum pond size is 800 m<sup>2</sup> since the culture system is very intensive. The 200–400 m<sup>2</sup> ponds are a good size for farmer who has limited land and capital.

## **SITE SUITABILITY**

Sites next to canals or rivers with adequate water of good quality supplied by gravity or tidal flow or by pumping and not too far inland are suitable for Snakehead culture. In Thailand Snakehead culture is practiced in Suphanburi, Nakorn Patom, Samut sakorn, Samut Songkhram, Nakorn Nayok, Samut Prakan, Chantaburi and Trad Provinces. Suphanburi is the largest farming area. The number of farm and farming area in 1981–1982 in each province is listed in Table 1

## **STOCKING AND REARING FRY**

Snakehead fry for stocking are collected from natural bodies of water. All farms obtain fry for stocking from private fry collectors or dealers in Prathumthanee, Samut Sakorn and Suphanburi. The fry are collected as ordered and, as such, some orders may take several day to complete. Fry are collected by dip net or trap net and transported from the spawning area to the dealer in 15-liter tin cans with 5-liter of water covered with Ipomea aquatica to prevent fish from jumping out. Fry are held over night in nylon net cages suspended in the rivers, canals, or ponds near the supplier's house and delivered to the farm the next day.

Snakehead fry are sold by weight or by container at the price of ฿ 50–60 per kilogram or ฿ 10 per container. On the average, one kilogram has 2,300 fry of 1.5–2.0 cm in length. The fry are directly stocked in the prepared nursing pond at the rate of 0.15–0.38 kg/m<sup>2</sup> or 345–874 fry/m<sup>2</sup>. Sometimes more than one trip is necessary by stocking is completed within 2–4 days.

The stocking period is from June to November but 65% of the farms stock in August, September and October which coincides with harvesting (Table 2). The survival rate from fry to fingerling (2 month) is variable and is fairly low, ranging from 7–24% because cannibalism is very bad at this stage and external parasites are not properly treated. When survival rate is high (24%) one nursing pond can produce enough

fingerlings to stock 3-grow-out ponds of the same size. If survival rate is low (7%) the fish will grow-out in the nursing pond till harvest.

Some less experienced farmer stock ponds with 10–15 gm fingerlings at the rate of 30–50 fish/m<sup>2</sup>. The price of fingerlings is about ₱ 50–60 per kilogram. The survival rate from fingerling to marketable size, 7–9 months is 85%.

## **FEED AND FEEDING**

Fry are fed with fresh trash fish alone or 95% trash fish and 5% rice bran, 4–5 time a day at 15% of body weight/day for the two months or nursing period. During the nursing period 0.5% of vitamin mix is supplemented in the diet and 0.1% peperazine as medication is added once very three weeks. Afterward the feed composition is changed to 90% trash fish and 10% rice bran. The feeding frequency is reduced to 2 times a day and feeding rate is reduced from 14 to 12% from the 3rd month to the 5th month. The feeding rate is reduced gradually from 12% to 4% from the 5th month to the 11th month. Therefore, the amount of feed given per day per pond is almost constant from the 5th month to the 11th month. The amount of feed given may be decreased to 75% on the 5th month and then kept constant, if feeding frequency is reduced to one time a day. This is usually practised in January and February, during the monsoon season when the supply of trash fish is low and price is high. The feed composition is also changed to 80–85% trash fish and 15–20% rice bran. (Table 2).

The trash fish and rice bran mixture are passed through a meat grinder, forming strands and dough. The dough is then placed on bamboo or wooden platforms which sink with the weight of the feed. An average of 12–15 platforms of size 75×50 cm, plat are placed all around the sides of the nursing ponds. In the grow-out pond only 5–6 small platforms or 2 large, 0.5 m × 3.0 m, platforms are place in each pond. The feed conversion ratio obtained from 45 farms surveyed ranged from 5.4:1 to 7.8:1. This variation was probably due to different feed quality and farm management.

## **DISEASE AND PARASITE**

Snakehead are very resistant to disease and parasites because the seed stock comes from the wild where natural selection take place. Disease and parasite have never resulted in great losses of Snakehead, except recently in early 1983, disease and abnormalities caused by environmental stress due to toxic substances contamination resulted in secondary infection by pathogenic agents and caused tremendous losses of natural fish and stocked fish. Vitamin B<sub>6</sub> deficiency disease has been recognized on harvested fish. Pathogens found in Snakehead fish are indicated in Table 3.

## **HARVESTING**

The culture period for Snakehead ranges from 7–11 months, from the months of August - October to May - July of the following year. Harvesting is done when the market price is

favourable after the fish have attained marketable size. From May to August supply from the wild is low therefore cultured fish receive a good price. The highest demand in the fresh fish market in Central Thailand is for a fish between 30–40 cm long and 450–600 gm in weight. In the Northern and Northeastern parts demand is for a fish under 30 cm long and weight under 400 gm. There is little demand for fish over 1kg., as it is quite expensive for the average consumer to purchase on fish. Therefore it is used by the canteen for making curry or fish casserole.

Harvesting is accomplished by lowering the water level in the rearing pond with a portable water pump, and then by seining. After seining the pond is drained completely and the whole crop is harvested. The collected fish are sorted into two sizes and immediately weighed into 50 kg. Lots and placed in wooden crates with water for delivery to market. Snakehead is always sold live since the price is reduced by 35% to 40% when dead.

In most cases, the wholesaler-buyer provides the necessary labour (5–6 men) and harvesting equipment, but the farmer pays for the labor at ฿ 80 /man/day or pays by crate at the cost ฿ 8 /crate, or per 50 kg. of harvested fish.

Fish price is generally determined by demand and supply. The average farm gate price in July 1982 was ฿ 35/kg. for small size and ฿ 37/kg for large size. The retail price in consumer markets ranged from ฿ 40–45/kg.

According to records collected from 45 farms, production ranged from 7–17 kg./m<sup>2</sup> crop. Production was much higher in 1980–1981 crop, 10–25 kg./m<sup>2</sup> because of different stocking rates, survival rates and management.

## **ECONOMIC PROFILE**

In order to understand the economics of Snakehead culture as traditionally practised in Thailand, a survey was conducted in April 1982. The objective of the economic survey are:

- to describe the socio-economic characteristics of Snakehead fish farming in the central region of Thailand (1981–1982)
- to analyse the economics of Snakehead fish production
- to study cost and returns to scale of production
- to identify economic problems and suggest methods to solve these problems

## **METHOD OF SELECTION OF SITES AND SAMPLES**

The central region of Thailand was the principal area for Snakehead fish production, (See Table 1) four provinces were chosen as representative sites of Snakehead fish culture.

The survey, conducted during April 1982, covered the last complete crop which, for most but not all farms, was the April to July 1981 crop.

Primary data was collected from farmers who cultured Snakehead fish in the 4 provinces selected. Simple random sampling was used for selection. A total of 45 farmers were interviewed, Table 4.

The interviews were conducted by Dr. Mali Boonyaratpalin, (NIFI) and students from the Faculty of Fisheries, Kasetsart University Bangkok. All data obtained were based on owners and managers recollection of activities for the most recently completed crop.

## **ECONOMICS FEATURE OF SNAKEHEAD FARMERS**

Socio-economics involves a combination of social and economics factors. The socio-economic factors include age distribution, experience, main and secondary occupation, and previous occupation of managers of Snakehead farm.

The percentage of farms by province classified by age of manager is shown in Table 5.

Most farmers were 31 to 50 years of age. However, it is of interest to note that a study of coastal fisherman in Thailand reported less than 50 per cent of the fisherman were in this age group, with the rest being distributed almost equally between the less-than -30 and over -50 age groups (Panayotou et. al. 1980).

An explanation for differences in age distribution between Snakehead fish farmers and coastal fishermen may be initial cost of capital investment. Snakehead fish farmers must have land and ponds plus related capital items including operating capital for feed and fingerlings. Coastal fishermen can use a variety of gear with very low to very high capital requirements. A second reason could be the relatively short history of Snakehead fish culture as compared to coastal fishing.

## **SNAKEHEAD FISH FARMERS EXPERIENCE**

Experience in fish farming may be more significant factor than age distribution in determining efficiency in production. Over time experience is gained in solving problems regarding pond design, water quality, feeding, disease control, selection of other in-put factors suitable for production, and other problems particular to fish farming. Moreover, fish farming requires a relatively regular timetable of activities. In crop farming, planting and harvesting are peak farm activities with less labour required between. In fish culture activities are spread throughout the rearing season. Stocking and harvesting may require less effort than feeding, disease control, and water management. An additional factor influencing experience is the relatively short history of Snakehead fish culture. Farmers in Suphanburi averaged 11.5 years experience, Nakorn Patom 4.2 years, Samut Sakorn 3.7 years, and Samut Songkhram 3.3 years

The percentage of farmers by main occupation is shown in Table 7. Most Snakehead fish farmers in Samut Sakorn and Nakorn Patom conducted the operation as a main occupation. In Samut Songkhram and Suphanburi most producers were crop farming. Samut Songkhram producers also had the least experience in Snakehead production.

Most fish farmers in Samut Songkhram reported fish production as a secondary occupation. Snakehead fish thus are only one fish enterprise in a fish farming operation, Table 8.

## **PREVIOUS OCCUPATION**

Thailand has been an agricultural country throughout its long history. The majority of the population have been engaged in agriculture.

With new employment opportunities in urban areas the population proportion in agriculture declined. In 1981, for example, the percentage engaged in agriculture in Samut Sakorn was 14.3 per cent. Industrial demand has increased land value and forced efficiency in agricultural use. Snakehead fish production is one method to intensify use of agricultural land.

## **FARM AND POND SIZE**

The farms sampled were generally small with the majority less than three rai in area (1 rai = 1,600 m<sup>2</sup>), Table 9. The largest Snakehead farm sampled was 15 rai in Suphanburi and the smallest was 0.11 rai in Samut Songkhram province. The land was wholly or partially owned by the operator in most instances. Fish culture requires investment in pond facilities and normally will not occur on rented land unless the owner provides the pond or the rental agreement is long term.

Pond size was also relatively small. In Suphanburi fish farmers had a relatively large number of big ponds, Table 10. With intensive feeding levels small ponds represent a lower risk and fewer management problems.

## **SEED PROCUREMENT**

Most farmers purchased fry or fingerling from collectors from the same or nearby province. None reported obtaining fry or fingerlings from a hatchery.

Fry was collection natural from waters. This was one reason survival rate of fry was high in these provinces. The fry were transported a short distance and were in good condition. Only in Samut Songkhram were most fry from other provinces, Table 11.

## **STOCKING RATE AND STOCKING FREQUENCY PER CROP**

Snakehead fish farmers utilize two structures for culture.

1. Cages
2. Ponds

For cages, stocking rate was high. Initial number was 10,000 small fingerlings per m<sup>2</sup>. After growing to 2–2.5 cm with a weight of 0.43 gm. fingerlings were redistributed to other cages or to ponds. The frequency of stocking for cages was not fixed.

For ponds, the stocking rate was not so high. Initial stocking of small fingerlings was 0.15–0.33 kg./m<sup>2</sup> or about 345–874 m<sup>2</sup>. Stocking rate was dependent on source and size of fingerlings. Fingerlings collected from natural water and immediately stocked in the pond were stocked at 200–400 m<sup>2</sup>. Survival rate for these fingerlings was only 13–15 per cent in the first three months. Larger fingerlings cultured in cages to a size exceeding 4 cm were stocked at 50–80 m<sup>2</sup>. Survival rate was over 80 per cent for the first three months.

## **CULTURE PERIOD**

The longest culture period was in Suphanburi with 11 months. For all sampled farmers, average length of culture period was 9.6 months. Relatively little difference existed between provinces.

## **FEEDING PRACTISE AND PROBLEMS**

In general farmer used trashfish mixed with rice-bran or broken-rice, Table 12. Feed was composed of trashfish, rice-bran, vitamins and minerals for the first month. Sometime farmers included antibiotics added to feed. Farmers used trashfish and broken-rice in the ratio from 10:1 to 17:1.

## **FEED CONTENT**

In general snakehead fish farmers used many kinds of feed as above but of the 45 sampled farmers 33.33% used trashfish and rice-bran while 66.67% used trashfish, rice-bran and broken-rice. In Samut Sakorn only trashfish and rice-bran were used while in Suphanburi trashfish, rice-bran and broken-rice were used, Table 12. The difference in feed composition between the two province may result from two factors. First, the high cost of trashfish in Suphanburi when cost of transportation is included. Second, the longer experience in culturing snakehead in Suphanburi. The farmers knew how to combine inputs with higher efficiency and cost of production primarily depends on the cost of feed. In Nakorn Patom and Samut Songkram both systems were used. The use of trashfish, rice-bran and broken-rice in Samut Songkram was higher than in Nakorn Patom. This may indicate that farmers in Samut Songkram were more aware of feed alternatives than farmers in Nakorn Patom.



## **MAIN PROBLEMS IN FEED SUPPLY**

The main problems in feed supply for farmers was high cost. Water pollution caused by feeding was second other problem include availability and quality of feed.

## **SUPPLEMENTAL FEED**

Supplemental feed consisted of concentrated feed, vitamin and other feed respectively. In Suphanburi the use of vitamins indicates Snakehead was cultured according to the recommendations of the Department of Fisheries.

## **FEEDING RATE**

The average initial feeding rate in Samut Sakorn, and Nakorn Patom was 16.31, and 12.34 per cent of body weight respectively. By harvest the feeding rates changed to 5.23 and 4.12 per cent in Nakorn Patom and Samut Sakorn respectively, Table 13.

In general there was as much variation among farmers in a province as between provinces. The highest initial rate was 21 in Samut Songkram. The lowest initial rate was 5.25 also in Samut Songkram. Many factors influence feeding rate including quality and availability of feed, and mortality of fish. The rates reported were relatively high compared to other carnivorous species.

## **HARVESTING**

Normally farmers cultured Snakehead fish from 8 months to 11 months depending on market demand, and capital after 8 months, weight was 0.5 kilogram. After 10 months weight was 0.7 kilogram.

Harvesting was dependent on market demand and supply after the fish reach marketable size. The average culture period as previously indicated was 9.6 months.

## **FOOD CONVERSION**

The lowest average feed conversion rate (FCR), was obtained in Suphanburi, Table 14. The lowest FCR was 3.09 in Samut Songkram and the highest was 8.1 in Samut Songkram.

## **PROBLEMS**

Problems were reported as follows:

1. Low survival rate especially in the initial period of culture

2. Slow growth of fish
3. Fish would not consume feed
4. Quality control
5. High cost of production

## **COST STRUCTURE AND PROFITABILITY**

Cost depends on input use and input prices while gross revenue is dependent on yield and output price. Net return is the difference between gross revenue and cost. Price for both input and output vary only moderately between farmers while quantities of input and output used vary widely. Thus, before discussing cost structure and profitability a comparative analysis of input use and yield for the four locations is presented.

## **YIELD AND INPUT USE**

Yield and inputs used with farm size, by province are shown in Table 15. In general, farmers in Suphanburi had more experience and larger pond area than in Nakorn Patom Samut Sakorn, and Samut Songkram.

Farmers with less experience tend to use higher levels of family labor. The mixture of stocking sizes makes analysis of stocking rate and yield relatively meaningless. The highest average yield was for large pond areas in Nakorn Patom which also had the lowest stocking weight.

## **COST STRUCTURE**

Cost have been classified into three broad categories:

1. Variable cost
2. Fixed cost
3. Opportunity cost

## **VARIABLE COST**

The variable costs dominate the cost structure of Snakehead farming. Variable costs accounted for over 96 per cent of total cost, the remainder about evenly divided between fixed and opportunity costs (Table 16). Farmers spent proportionately more on feed than on fingerlings, hired labor, fuel and maintenance. The latter were not highly significant when compare with feed cost.

## **FIXED COST**

Fixed costs as a percentage of total costs were relatively low. The average farm under each type of culture spent less than 20,000 bahts on fixed cost. Suphanburi farmers had

the lowest proportion of fixed costs but not the lowest absolute amount. Variable costs were two to three times higher in this province.

## **OPPORTUNITY COSTS**

The opportunity cost of owned inputs of land, family labor and interest of fixed capital, was of relatively minor importance. Most of the opportunity cost was family labor. Suphanburi had the lowest percentage and the lowest absolute amount.

Total costs were converted to average terms, that is per unit of pond area and per unit of output produced for Table 17. In Suphanburi production from one square meter of pond area cost about 230.97 baht in variable cost, 2.82 baht in fixed costs and 4.41 baht in opportunity costs. Total cost per square meter of pond area was 238.2 bahts.

The average net profit per square meter of pond area was highest in Suphanburi (112.32 baht) and lowest in Samut Sakorn (49.69 baht). Suphanburi farmers had larger pond area and more experience in production. Average yield per m<sup>2</sup> highest but average cost was relatively low. Samut Songkram farmers had the highest gross revenue but variable feed and opportunity costs reduced net profit.

## **THE RELATIONSHIP BETWEEN PROFIT AND EXPERIENCE OF OPERATOR:**

The Snakehead farm data was subdivided based on the years of experience of the operator within the province. Those with years of operating experience above the average were classified as experienced, below the average number of years as unexperienced. The averages used were 11.5, 4.3, 3.7, and 3.3 for Suphanburi, Nakorn Patom, Samut Sakorn, and Samut Songkram respectively. An unexperienced farmer in Suphanburi thus may have more experience than an experienced farmer in one of the remaining provinces.

Net profit appeared to be related to average yield which was associated with years of experience, Table 18. In Suphanburi the less experienced group had higher yield and net profit. The difference yield between experienced and unexperienced farmers was much lower, perhaps because the volume of fish per harvest was much higher.

Overall experienced farmers should have established efficient production techniques and found market outlet. The less efficient have gone out of business over time. Why Suphanburi farmers do not follow this trend may be related to the relatively long years of operation by the group classified as unexperienced.

## **THE RELATION BETWEEN FARM SIZE AND PROFIT**

As indicated in the previous chapter, farm size is one of the factors determining production and profit.

In Suphanburi, the net profit for medium size was higher than large size even though gross revenues of large farm size was higher than medium size. The different was due to the variable costs. For medium size variable costs were only 36 per cent of variable costs of large size while revenue was 48 per cent.

In Nakorn Patom, the medium farm size had negative net profit while both small and large farm size had positive net profit. From Table 19, the medium size farmers were inexperienced thus the relationship was based on experience in determining yield. The gross revenues of large farm size was proportionally higher than small size.

In Samut Sakorn, only small and large farm size were present with average area of 496 m<sup>2</sup> and 3,564 m<sup>2</sup> respectively. The gross revenue of large farm size was higher than small farm size approximately in proportion to the difference in area. Small size had negative net profit primarily because of high opportunity costs relative to gross revenue. The small farm size were inexperienced as in Nakorn Patom.

In Samut Songkram, only the small and medium farm size were present. With the average area of 432 and 1,376 m<sup>2</sup> respectively. The gross revenue for medium size was 70 per cent higher than for small farm size. The total cost for medium size was 141 percent higher than for small farm size. The net profit for medium size was less than for the small size.

Farmer's experienced and farm size both have to be considered in yield, returns and profit. In general experience seemed to be more important than pond area.

## **SUMMARY OF COST STRUCTURE AND PROFITABILITY**

Economic tools are available to assist in determining efficiency of input use. One such analysis would consider whether the input mix is in the proper proportion. All such models assume that a defined resource the same measurable quantity. Field research indicated the Snakehead fish data did not meet this criteria. First, the stocking rate (weight) represent at least three different sizes and two different production systems. Second, feed was not standardized and the relative proportions in a mix was dependent on the availability of trashfish. Third, length of culture period was a function of demand and the pond might be partially harvested several times.

A production model then should include feed cost and growth rate per month, pond size, location, experience of operator, previous production history of ponds, average production from ponds in close proximity. Such input data would allow assessment of:

Stocking number and initial stocking size  
Marginal growth rate with different feeding rates  
Interaction of growth with pond size  
Interaction of growth with location (geographical differences)  
Interaction of growth with managerial ability  
Longitudinal study and the learning curve  
Comparative production

The study would require a larger sample size and monthly records including growth samples from each producer.

In general economic data as collected for this study can only yield guidelines in production. The study indicates research should continue on manufactured feed to insure a stable supply. Stocking large fingerlings also appears warranted and the fry grow out to fingerlings could be expanded. Market coordination also needs improvement since producers often hold the fish for months after they have reached market size.

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Feed Composition (Trash Fish:Rice Bran)	10.0	9.5:0.5	9:1	9:1	8.5:1.5	8.5:1.5	8.5:1.5	8.5:1.5	8:2	8:2	8:2	8:2
Protein in diet (%)	54	51.8	49.6	49.6	49.6	47.4	47.4	45.2	45.2	45.2	45.2	45.2

Table 3 Pathogen found in Snakehead and treatment, Boonyaratpalin 1983a, 1983b, Sirikanjana 1983a, 1983b.

	<u>PATHOGENS</u>	<u>TREATMENT</u>
	Bacteria	
	<u>Aeromonas punctata</u>	
1)	<u>Flavobacterium spp.</u>	Feed added with sensitive antibiotic
	<u>Pseudomonas spp.</u>	
	<u>Haemophilus piscium</u>	
	Internal Parasite	
	Cestode, <u>Senga Malayama</u>	
2)	Acenthocephalus, <u>Pallisentis</u>	0.1% peperazine in feed, once every three weeks, twice a crop.
	<u>Nagpurensis</u>	
	Nematode, <u>Camallanus yehi</u>	
	<u>Spinitectus sp.</u>	
	External Parasites	
	Protozoa, Glossatella	
	Epistylis	2–3 treatments, once every other day of 30–35 ppm.
3)	Trichodina	formalin or 0.1–0.25 ppm.
	Costia	dipterex.
	monogenetic, Daetylogyrus	
	Dryidaetylus	

Table 4 Number of Snakehead Fish Farmers interviewed in four provinces, Thailand.

PROVINCE	NUMBER FARMS NO.	NUMBER Interviewed No.	PERCENTAGE Interviewed %
Suphanburi	40	16	40
Nakorn Patom	16	6	38
Samut Sakorn	9	7	78
Samut Songkhram	40	16	40
Total	105	45	43

Table 5 Percentage of Snakehead Fish Farmers by years of Experience in four Provinces, Thailand 1982

EXPERIENCE Years	PROVINCE			
	Suphanburi %	Samut Sakorn %	Samut Songkhram %	Nakorn Patom %
1-5	22.2	80.0	90.5	50.0
6-10	55.6	20.0	9.5	50.0
Over 10	22.2	-	-	-
Total	100.0	100.0	100.0	100.0

Table 7 Percentage of Snakehead Fish Farmers by main occupation in four provinces, Thailand 1982



MAIN OCCUPATION	PROVINCE			
	Suphanburi %	Samut Sakorn %	Samut Songkhram %	Nakorn Patom %
Culture Snakehead Fish	37.5	71.4	31.2	66.7
Crop Farming	54.7	14.2	56.2	16.6
Non Agricultural	18.7	14.2	12.6	16.7
Total	100.0	100.0	100.0	100.0

Table 8 Percentage of Snakehead Fish Farmers by secondary occupation in four provinces, Thailand 1982.

SECONDARY OCCUPATION	PROVINCE			
	Suphanburi	Samut Sakorn	Samut Songkhram	Nakorn Patom
Fish Farming	50.0	42.9	62.5	16.7
Crop Farming	18.7	42.9	31.2	50.0
Non Agricultural	31.3	14.2	6.3	33.3
Total	100.0	100.0	100.0	100.0

Table 9 Size and land ownership of Snakehead Farms in four provinces, Thailand 1982.

ITEM	PROVINCES			
	Suphanburi	Nakorn Patom	Samut Sakorn	Samut Songkhram
SAMPLE SIZE NO.	16	6	7	16
<u>FARM SIZE</u>	%	%	%	%
1–3 Rai	68.75	50.00	85.71	62.50
3–6 Rai	12.50	33.33	-	37.50
More than 6 Rai	18.75	16.67	14.29	-
<u>LAND OWNERSHIP</u>				
Owned	56.25	50.00	100.00	75.00
Partially Owned	12.50	50.00	-	6.25
Rented	31.25	-	-	18.75

Table 10 Area and Number of ponds for Snakehead farms in four provinces, Thailand 1982.

ITEM	PROVINCES			
	Suphanburi %	Nakorn Patom %	Samut Sakorn %	Samut Songkhram %
<u>POND AREA</u>				
Upto 1,000 M <sup>2</sup>	6.25	16.67	57.16	60.25
1,001–3,000 M <sup>2</sup>	43.75	33.33	14.28	39.75
More than 3,000 M <sup>2</sup>	50.00	50.00	28.56	-
Average (M <sup>2</sup> )	5,009	2,989	1,856	784
<u>NUMBER OF POND</u>				
1–3	50.00	50.00	57.14	62.50
4–6	37.50	16.67	42.86	37.50
7–9	6.25	16.67	-	-
More than 9	6.25	16.67	-	-

Table 11. Stocking practices and water systems in Snakehead farms in four provinces, Thailand 1982.

ITEM	PROVINCES			
	Suphanburi %	Nakorn Patom %	Samut Sakorn %	Samut Songkhram %
<u>SOURCE OF FRY</u>				
Local collector	68.75	83.33	57.14	12.50
Other province	31.25	16.67	42.86	87.50
<u>SOURCE OF WATER</u>				
Natural	25.00	100.00	100.00	100.00
Irrigation	75.00	-	-	-
<u>QUALITY OF WATER</u>				
Good	87.50	-	57.14	25.00
Moderately-good	12.50	100.00	28.57	56.25
No-data	-	-	14.29	18.75

Table 12 Feeding practices and problem in Sankehead Farms in four provinces, Thailand 1982

ITEM	PROVINCES			
	Suphan Buri %	Nakorn Patom %	Samut Sakorn %	Samut Songkhram %
<u>FEED CONTENT</u>				
Trashfish and Rice-Bran	-	50.00	100.00	15.75
Trashfish, Rice-Bran and Broken rice	100.00	50.00	-	84.25
<u>MAIN PROBLEM IN FEED SUPPLY</u>				
High cost	66.67	50.00	33.33	75.00
Water pollution	20.83	40.00	20.86	50.00
Other <sup>1</sup>	12.50	30.00	35.81	35.00
<u>SUPPLEMENTAL FEED</u>				

Concentrated feed	31.58	33.33	33.23	40.00
Vitamin	47.99	33.33	50.00	20.00
Other <sup>2</sup>	20.53	33.34	16.67	40.00

1. Includes no problem farms
2. Includes medicines

Table 13 Feeding rate by Snakehead fish farmers in four provinces, Thailand 1982.

Farm No	SUPHANBURI		NAKORN PATOM		SAMUT SAKORN		SAMUT SONGKHRAM	
	Initial	Harvesting	Initial	Harvesting	Initial	Harvesting	Initial	Harvesting
1	23.18	-	8.18	4.25	16.00	3.12	5.26	5.68
2	20.63	2.93	8.57	7.20	-	5.00	8.00	4.70
3	15.00	2.96	16.66	2.60	10.00	2.60	8.33	4.17
4	-	4.80	16.61	10.05	18.78	4.00	11.01	6.70
5	11.09	3.22	7.32	2.78	6.75	4.67	12.22	6.29
6	9.43	8.00	17.06	4.50	-	4.74	20.00	5.60
7	15.52	7.24			30.00	4.68	21.00	4.72
8	-	3.22					16.04	5.38
9	16.66	8.45					8.00	4.00
10	17.14	3.60					20.00	5.60
11	6.30	3.42					8.28	4.66
$\bar{x}$	14.99	4.78	12.34	5.23	16.31	4.12	12.56	4.95

Table 14 Feed conversion ratio for Snakehead fish farmers in four provinces, Thailand 1982.

FARM NO.	PROVINCES			
	Suphanburi	Nakorn Patom	Samut Sakorn	Samut Songkhram
1	5.72	7.64	3.47	3.09
2	4.80	4.50	9.40	7.75
3	4.96	4.80	4.80	7.68
4	5.80	5.60	4.76	7.87
5	4.30	6.50	6.51	7.56
6	6.07		6.69	6.32
7	6.60		7.98	7.45
8	5.12			6.58
9	5.60			6.70
10	5.40			6.61
11				4.21
12				7.37
13				5.33
14				8.10
$\bar{x}$	5.44	5.81	6.23	6.62

Table 15 Farm size, average yield and input use in 45 Snakehead farms in four provinces, Thailand 1982.

ITEM	Suphanburi		Nakorn Patom			Samut Sakorn			Samut Songkhram		
	<u>2</u>	<u>3</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>1</u>	<u>2</u>	<u>3</u>
Sample size (Farms)	7	9	4	1	2	10	6	-	1	2	3
Average farm size (M <sup>2</sup> of pond area)	2,192	7,712									
Average yield (Kg/M <sup>2</sup> )	13.19	9.85	3.18	5.33	16.51	9.21	1.43	-	7.59	10.55	8.14
Stocking rate (Kg/M <sup>2</sup> )	0.84	0.30	0.17	0.33	0.15	0.32	0.40	-	0.58	0.53	0.17
Conversion ratio (Feed/Yield)	0.29	5.36	5.25	7.40	6.59	6.58	6.26	-	5.42	7.17	5.66
Fuel used (฿/M <sup>2</sup> )	5.19	3.89	6.82	11.79	10.82	10.68	17.86	-	7.87	13.72	9.91

Family labor (฿/M <sup>2</sup> )	7.65	1.93	20.41	25.89	14.62	57.83	24.52	-	8.44	10.82	4.38
Culture period (Months)	8.80	11.00	10.00	8.00	10.00	9.30	9.80	-	7.00	9	9.7
Farmers experience (Years)	7.00	9.77	4.50	2.00	5.00	3.4	4.34	-	3.0	4.0	3.0

1 Pond area (water surface) less than 1,001 M<sup>2</sup>

2 Farms with pond area between 1,001M<sup>2</sup> to 3,000 M<sup>2</sup>

3 Farms with pond area larger than 3,000 M<sup>2</sup>

Table 16 Cost structure of 45 Snakehead farms on four provinces, Thailand 1982.

ITEM	SUPHANBURI		NAKORN PATOM		SAMUT SAKORN		SAMUT SONGKHRAM	
	฿	%	฿	%	฿	%	฿	%
<b>VARIABLE COST (฿/FARM)</b>	1,156,915.25	96.95	504,850.50	90.82	459,516.37	89.83	203,240.33	83.31
Fingerlings	77,623.00	6.70	52,421.67	10.38	13,184.29	2.87	15,980.56	9.09
Feed	957,037.00	82.72	387,830.83	76.82	416,977.79	90.74	161,273.06	81.63
Fuel	59,068.46	5.11	49,374.67	9.78	15,642.86	3.40	12,069.71	6.10
Hire Labor	43,201.42	3.73	4,173.33	0.83	6,988.57	1.53	11,279.31	2.84
Maintenance <sup>1</sup>	20,165.36	1.34	11,050.00	2.19	6,722.86	1.46	2,637.19	1.34
TOTAL	1,156,915.25	100.00	504,850.50	100.00	459,516.37	100.00	203,240.33	100.00
<b>FIX COST (฿/FARM)</b>	14,130.34	1.19	17,202.50	3.09	9,282.96	1.81	8,497.12	3.59
Depreciation of facilities <sup>2</sup>	14,130.34	100.00	17,202.50	100.00	9,282.96	100.00	8,497.12	100.00
TOTAL	14,130.34	100.00	17,202.50	100.00	9,282.96	100.00	8,497.12	100.00
<b>OPPORTUNITY COSTS (฿/FARM)</b>	22,099.36	1.85	33,900.00	6.09	42,754.22	8.36	31,075.95	13.10
Family labor	12,053.56	54.54	18,900.00	55.75	32,978.57	77.14	27,635.29	88.93
Interest of fixe capital	10,045.80	45.46	15,000.00	44.25	9,775.65	22.86	3,440.60	11.07
TOTAL	22,099.36	100.00	33,900.00	100.00	42,754.22	100.00	31,075.95	100.00
TOTAL COSTS	1,193,144.90	100.00	555,953.00	100.00	511,553.55	100.00	237,142.65	100.00

1 Includes only maintenance of buildings machinery and equipment, pond maintenance consisted mainly of labor costs and the other variable cost.

2 Facilities, includes building, machineries and add equipment.

**Table 17** Average profit per square meter of pond area in Snakehead fish farms in four provinces, Thailand 1982.

ITEM	PROVINCES			
	Suphanburi	Nakorn Patom	Samut Sakorn	Samut Songkhram
Sampled size (Farms)	16	6	7	16
Average pond area (M <sup>2</sup> /Farm)	5,009	2,989.33	1,856	784
Average yield (Kg/M <sup>2</sup> )	12.26	8.57	7.30	10.04
<u>Gross Revenues</u> (฿/M <sup>2</sup> )	349.98	274.52	325.58	420.99
<u>Cost</u> (฿/M <sup>2</sup> )				
Variable costs	230.97	168.88	247.58	259.24
Fixed costs	2.82	5.76	5.00	10.84
Opportunity costs	4.41	11.34	23.04	39.64
TOTAL	238.20	185.98	275.00	309.72
<u>Return</u> (฿/M <sup>2</sup> )				
Operating profit <sup>1</sup>	119.01	105.64	78.00	161.75
Net income <sup>2</sup>	116.73	99.84	73.00	150.91
Net profit <sup>3</sup>	112.32	88.54	49.96	111.27

<sup>1</sup> Gross revenue - variable cost

<sup>2</sup> Operating profit - fixed cost

<sup>3</sup> Net income - opportunity cost

**Table 18** Farmer's experience, average revenue, cost, profit per square meter of pond area in Snakehead Fish farms in four provinces, Thailand 1982.

ITEM	SUPHANBURI		NAKORN PATOM		SAMUT SAKORN		SAMUT SONGKHRAM	
	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
Sample size (Farms)	12	4	2	4	3	4	9	7
Average pond area (M <sup>2</sup> /Farm)	3,793.33	9,812.00	2,896.00	3,036.00	677.33	2,744.00	793.00	847.00





Operating profit	474,534	525,665	45,619	36,514	288,797	5,089	451,242	140,748	37,266
Net Income	466,703	502,789	32,001	22,441	268,885	2,061	427,801	132,626	27,454
Net Profit	447,116	375,792	4,385	-18,882	281,966	-49,554	402,104	92,051	3,364

- 1 No data of small farm size
  - 2 No data of medium farm size
  - 3 No data of large farm size
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