

THE GOVERNMENTS OF MALAYSIA AND THE STATE OF JOHOR

W.P. INLAND FISHERIES

## **WORKING PAPER**

**JOHOR TENGAH AND TANJONG PENGGERANG REGIONAL MASTER PLAN**

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WORKING PAPER  
INLAND FISHERIES

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## WORKING PAPER

### INLAND FISHERIES

#### 1. INTRODUCTION

The results of nutritional surveys and studies in Malaysia have shown that a concealed form of hunger, malnutrition due to protein deficiency, is common and widespread, particularly among the rural population. This hidden danger gravely affects the health, efficiency and economy of the rural population and the nation as a whole. An increase in fish production and consumption would provide this protein in a food that is the most popular source of protein in the Malaysian people's diet.

#### 2. PRESENT SITUATION

##### 2.1 Fresh Waters

Except for the S. Johore itself large rivers and fresh water lakes are not found in Johore State and the natural fresh waters that do exist are of low productivity since they are poor in nutrient salts due to the closed cycle of nutrients on land covered with jungle. With clearance of this jungle these rivers will become loaded with silt and show increasingly unstable flow conditions. The natural fresh waters therefore have a low potential for direct fisheries exploitation.

Further, unlike Selangor and Perak, two leading fish culture states, Johor has few easily adaptable sites, such as mining pools, close to population centres.

In addition to these natural constraints, development is inhibited by lack of supplies of fish fry, which the small, but dynamic, State Fisheries Department can at present obtain only from the federal multiplication stations in Selangor and Pahang. The construction in Johor of a fry multiplication centre during the Second Malaysia Plan period would provide a stimulus to inland fisheries development, which at present is relatively backward in the state.

##### 2.2 Brackish Waters

The coastline of Tanjong Penggerang has a great many mangrove swamps, particularly on its west side along the S. Johore estuary. These swamps, as breeding grounds for mosquitoes, are a menace to health and are of little use for agriculture. In certain places, with minor engineering works, they can be made to yield high value crops of prawns and crabs. At present there are some 350 acres of these prawn ponds on the Tanjong Penggerang coast. They are made by enclosing as large an area of swamp as possible (minimum size about 10 acres) with mud bunds. The height of the bunds varies with the height of high water at spring tide. Sluice

TABLE 1      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE ON FISH AND MEAT

Income Group	\$0-99		\$100-199		\$200-299		\$300-499		\$500-749		\$750-1,000+	
	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat	Fish	Meat
\$ 0-4.99	57	183	32	186	4	39	5	15	2	3	4	1
\$ 5-9.99	47	25	78	158	18	48	10	36	5	8	4	6
\$ 10-19.99	72	16	191	73	55	43	35	32	12	13	4	11
\$ 20-29.99	31	10	144	67	83	46	48	37	21	10	6	3
\$ 30-39.99	17	8	108	64	69	50	57	51	16	18	14	6
\$ 40-49.99	11	6	54	49	55	49	47	27	8	12	11	5
\$ 50-59.99	5	2	28	31	24	36	40	24	12	8	3	8
\$ 60-79.99	4	1	31	29	40	32	44	50	23	24	9	15
\$ 80-99.99	3	1	9	13	8	17	18	31	11	18	10	19
\$100+	1	-	7	2	10	14	11	24	11	10	16	15
Not clear or No answer	10	6	6	16	14	6	15	3	3	-	8	-

gates are constructed in the bunds, the number depending on the area of water impounded, so that the water can flow in and out without creating too much pressure on the bunds. Most of the mangrove within the pond area is cleared and channels are cut in the mud leading to the sluice gates so that the pond can be totally drained. The sluice gates are situated so that the tide flows into the pond directly from the sea or estuary. Unfortunately all sites suitable for pond construction do not necessarily make suitable places for pond operation. The system of operation relies on the supply of prawn larvae being carried on certain tides into the ponds where they settle down on the bottom to feed and develop. When they attain a size of 2-3 inches they move out to the sea to breed. In doing so they have to pass the sluice where they are caught in a filter bag net. The supply of prawn larvae at different sites along the coast is very variable, and at present there is no system of artificially 'seeding' ponds with prawn larvae. This uncertainty of production along with the high cost of pond construction has discouraged development of all but a few of the present potential sites. Much interest is being shown, however, in the artificial spawning of many prawn species so these brackish water areas could have a good reserve potential for development.

In other parts of the world brackish water ponds are used for raising fish, but in Malaysia this is done at present on only a very minor scale. Several species of garoupas, grey mullets and the milk fish are all high value species that will only thrive well in brackish waters. But before techniques to raise these species in Malaysia become known much research is required into their life histories and spawning behaviour.

### 3. THE PRESENT MARKET AND PROJECTED DEMAND FOR FISH

That rice is the staple food of the Malaysian diet is an accepted fact. It is not so well known that fish is by far the most popular protein food. Data from the consumer expenditure survey carried out by the Consultants in 1970 (Agricultural Working Paper) provide information to illustrate the expenditure on fish and meat by all races at different income levels. (Table 1) Some of the higher figures should be treated with caution. The householder with a low income of only \$100 per month who spent it all on meat was not an obligate carnivore but a satay seller. These cases are exceptional and it is the median figures which show that at lower income levels fish is the almost exclusive animal protein source.

The actual quantity of fish consumed in Malaysia is difficult to determine. This problem has been discussed at some length by Berube who gave data from three different types of sources:-

- (a) From records of purchases in given markets where three studies indicated an average annual consumption of 109 pounds per head.
- (b) From measurements of the proportion of fish proteins in the diet obtained during nutrition studies in various parts of the country. Four studies of this type gave an average per capita consumption of 75 pounds per head.
- (c) From national statistics of production, imports, exports and feed usage indicating total fish disappearance. The figures resulted in an estimated per capita consumption of 45 pounds per head.

Of the three sources, the first is probably the least reliable. The other two are both obviously subject to error. F.A.O. estimated per capita consumption in 1962 as 30.1 kg/head per year (or 66 pounds/head). This appears to be reasonable in the light of the above data. This is projected to rise to about 38 kg. per head by 1985 given an income elasticity of demand of 0.4.

The F.A.O. projections of fish production, trade and usage for different types of fish products are given in Table 2. These estimates are somewhat at variance with the results from the consumer survey (Table 3) which suggest a swing towards the more luxury items such as fresh prawns and crabs and away from freshwater fish and dried fish. The F.A.O. figures indicate a declining per capita consumption of crustacea and a rapidly increasing consumption of molluscs, both of which projections seem questionable.

The survey indicates at first glance a discouragingly low freshwater fish consumption. However, the survey was carried out mainly in towns and suburbs, where such types of fish could be less easily obtained than in the rural areas. Some 1800 persons, mostly housewives, were asked why they did not buy freshwater fish. (Table 4).

TABLE 4      REASONS FOR NOT BUYING FRESHWATER FISH

Income Group	\$0-99	\$100-199	\$200-299	\$300-499	\$500-749	\$750- 1000	%
Reasons							
Don't like it	137	375	196	181	77	46	55.5
Too expensive	7	29	17	6		1	3.29
Not available	92	248	132	111	38	26	35.52
Never tried it	5	12	9	10	4	4	2.41
Other	8	22	14	9	3	2	3.18

TABLE 2

PRODUCTION AND UTILISATION OF FISHERY PRODUCTS, WEST  
MALAYSIA, 1962 - 1985

000' ton

1962 - 1985	Production	Net Trade (+ = import)	Supply	Use	
				Food	Feed
<u>1962</u>					
Demersal	34	-	34	25	9
Pelagic	104	-	104	84	20
Crustaceans	20	-	20	20	-
Molluscs	13	+6	19	19	-
Freshwater	25	-	25	25	-
Fishmeal	-	+7	7	-	7
<u>1975</u>					
Demersal	65	-	65	32	33
Pelagic	159	-29	130	110	20
Crustaceans	27	-7	20	20	-
Molluscs	47	+7	54	54	-
Freshwater	35	-	35	35	-
Fishmeal	-	+12	12	-	12
<u>1985</u>					
Demersal	105	-	105	65	40
Pelagic	209	-41	168	133	35
Crustaceans	30	-8	22	22	-
Molluscs	72	+10	82	82	-
Freshwater	41	-	41	41	-
Fishmeal	-	+12	12	-	12

Source: F.A.O. Indicative World Plan for Agriculture

TABLE 3      AVERAGE MONTHLY EXPENDITURES PER HOUSEHOLD BY MONTHLY  
INCOME AND TYPE OF FISH PRODUCT

Type of Product	Monthly Income Group				
	\$0-99	\$100-199	\$200-299	\$300-499	\$500 & over
(a) Malays					
All Fish	16.70	26.73	38.16	45.82	60.2
Fresh sea Fish	10.20	17.71	24.66	29.59	33.45
Dried Fish	2.45	4.16	2.52	2.16	2.96
Freshwater Fish	0.35	0.33	0.33	0.34	3.24
Crabs	0.34	0.60	0.83	1.24	2.27
Fresh Prawns	1.32	2.59	3.83	4.66	5.29
Dried Prawns	0.56	0.81	1.06	1.64	1.90
Cuttle Fish	0.86	1.26	1.99	1.98	3.00
(b) Chinese					
All Fish	19.34	28.81	37.97	41.75	47.50
Fresh Sea Fish	15.95	21.41	25.92	28.92	28.36
Dried Fish	0.67	1.18	1.93	1.52	1.56
Freshwater Fish	0.12	0.53	0.69	0.41	0.64
Crabs	0.39	0.59	1.29	1.08	2.15
Fresh Prawns	0.98	2.25	2.97	3.63	4.84
Dried Prawns	0.51	0.73	0.92	1.04	1.00
Cuttle Fish	0.44	0.66	1.33	1.27	1.48

Source: Consultants' Consumer Survey, 1970.

More than half the respondents said that they did not like freshwater fish. However one third replied that it was not available. When asked if they would buy more if it were available 43 percent replied that they would. (Table 5)

TABLE 5                      WOULD YOU BUY MORE FRESH WATER FISH?

Income Group	\$0-99	\$100- 199	\$200- 299	\$300- 499	\$500- 749	\$750 1,000+	%
If more was available	111	310	169	133	38	39	43.16
If cheaper	4	26	14	5	6	2	3.11
Would not	137	351	186	181	79	49	53.71

The consumer expenditure survey was carried out in Johore Baharu and in localities in South Johore. The main demand is in Johore Baharu and freshwater fish are hardly ever available in the market. Johore State is comparatively backward in freshwater fish production, and any production in South Johore is likely to be sold in Singapore where the Chinese carps obtain a good price. The 25,000 metric tons which enter the official trade figures are sold more in the central and northern towns, particularly Seremban, Kuala Lumpur and Ipoh, where freshwater fish are available daily.

It should be remembered that it is in the rural areas where the greatest need lies. Here the supply of fresh fish from marine sources is often small and quality very poor compared with the town supplies. It is only those fish surplus to the Johor Baharu market requirement that get hawked in the rural areas. It frequently happens that the wholesomeness of the fish is greatly impaired by the time it reaches the kampong. As a result rural people rely more on dried marine fish; to some extent they have developed a preference for it (it is also cheaper than fresh fish) and this further depresses the market for fresh marine fish. The nutritive value of fish is much reduced by the drying and salting processes, which destroy vitamins and alter some of the proteins so that they become unavailable to the human digestive system. The big advantage of inland fish culture is that fresh fish are raised close to the areas where they are to be consumed; further, rural people are already familiar with freshwater fish from padi fields, drains and rivers so that there is no sales resistance to this commodity.

The market for freshwater fish may therefore be viewed as having two parts (1) the local demand for fresh fish, which can be satisfied

only from freshwater supplies because of the distance from marine fish sources, and (2) the speciality fish market, concentrated in towns and probably linked with the restaurant trade. The former demand will be mainly for Tilapia, Lampan Jawa and other small to medium sized fish, weighing about one pound each. The latter will be mainly for China carps and other larger fish.

The potential level of consumption of freshwater fish in rural areas is difficult to determine. Projections of national consumption of fish products indicate a rise over the next 20 years to 100 pounds per head per annum. Rural and interior areas will probably always consume rather less than urban and coastal areas because sea food is less easily made available in fresh condition. However, assuming consumption in the project areas rises to about 75 pounds/head per annum, it would not appear unreasonable to assume that about 25 pounds or one-third of this will be of freshwater fish, provided supply is regular and known to be fresh. Estimates of profitability suggest that rates of return of 10-20 percent are possible with producer prices of 50-60 cents per kati (40-45 cents per pound) for lower value fish for general consumption. This could mean local retail prices of about 60 cents per pound which would be extremely competitive compared with other animal protein sources.

The consumer survey suggested higher than average income elasticities of demand for more luxury and exotic types of sea food. There appears to be no reason to expect that this does not apply equally to Chinese Carp as much as to prawns and crabs. The actual level of consumption is impossible to project with useful accuracy.

By 1990 the project area could have a rural population of approximately 100,000, consuming annually  $2\frac{1}{2}$  million pounds of fresh water fish, worth at farm gate prices  $1\frac{1}{4}$  million dollars; this quantity could be produced from 1,250 acres of fish ponds.

The urban population within the area and in peripheral towns could reach 250,000 by 1990. This population is better supplied with fish from marine sources and annual consumption of freshwater fish is conservatively estimated at 2 pounds per head, or  $\frac{1}{2}$  million pounds in all, worth \$1 per pound at the farm gate; this quantity could be produced from 250 acres.

Another market which could be well supplied from the project area is the district of Johore Baharu which may have a population upwards of 500,000 by 1990. These people will be well supplied with fish of marine origin but it is considered they will consume one pound per head per annum of special occasion freshwater fish. Thus a further 500,000 pounds of fish will be required from another 250 acres. Singapore too

will be a good market for special occasion fish and by 1990 it is projected the population will be 3 million, which at half pound per head per annum will require, 1,500,000 pounds, which could be produced from 750 acres. Systems raising carp for this luxury market could give rates of return of about 30 percent.

By 1990 there could be a total requirement for 5 million pounds of fish, which could be produced from 2,500 acres of ponds by the present known extensive methods. This is likely to be the minimum demand, because the Indicative World Plan for Agriculture states that by 1985 the maximum exploitation of known food species from the sea will have been reached. In Malaysia it is known that the existing pelagic fisheries are yielding at about their maximum potential, now, although there is a large untapped potential in the demersal fisheries.

The plan also indicates that, with increasing world population and the unequal increase in incomes, the demand for mammalian meat will rise faster than the already inadequate supplies. This could lead to a rise in prices and it is likely that in the middle and lower income groups there could be an increasing substitution of fish for mammalian meat. Only chickens and pigs have the potential to provide cheap meat. It is likely therefore that the demand for protein from aquatic sources could rise beyond the present consumption trends.

#### 4. THE ENVIRONMENT

##### 4.1 Climate

The range of temperatures prevailing in Johore can be considered ideal for fish growth. There is a maximum seasonal and diurnal range of water temperatures of 10°F, from 75°F to 85°F.

The annual rainfall patterns indicate that a drought period is likely only for a short duration at one time of the year. This means that ponds can be operated all the year round with no restrictions from water supplies.

Fish pond productivity relies partly on light intensity so that the available hours of bright sunshine might be considered critical. However, in considering total productivity from a pond, it is usual for other factors to become limiting long before the hours of sunshine are critical. During the monsoon seasons days with heavily overcast skies and frequent rain showers can result in oxygen depletion of the water. Should these conditions coincide with overstocking and abnormally rich water then fish deaths are possible due to oxygen deficiency. These conditions are rare and can be avoided by good management.

#### 4.2 Water

The water supply can come from a river, stream, canal or from pumped groundwater. It is important that, while large quantities of water are not required permanently, some water is always available as ponds do require regular topping up. The amount of water available in the Project Area is most likely to limit fish culture development by being in excess rather than from any deficiency, and adequate drainage must be provided to alleviate possible effects from flooding.

The second major constraint is the danger from pollution of water and the increase in agricultural, industrial, and urban development will make it increasingly difficult to obtain water supplies free of toxic chemicals. Fresh water enriched with agricultural fertilizers from run off or with domestic and livestock sewage can still be used for pond culture but the fertilizer programme will require amending. The use of water contaminated with dung would be objectionable to certain sections of the population and in such cases it would be best to use pumped groundwaters if the purity of the supplies cannot be guaranteed.

#### 4.3 Soils

For pond construction the soils should have an adequate clay or silt content to hold water; 40 percent clay is suitable. Sandy soils even if they are low lying lose water and nutrients through seepage. The nutrient status of the soil is not important as it is only the surface one centimeter of soil that takes part in ionic exchanges with the water. The nutrition of the pond water must come from outside the pond and not from the pond soil.

Most of the dry land soils, that is those not directly associated with river valley systems, are suitable for pond construction but those that contain large amounts of laterite or stones should be avoided. The **wet land** soils that are associated with valley systems and subject to permanent or temporary flooding are of varying usefulness. The acid sulphate soils of the Kranji Series in the project area are all subject to tidal influences and are suitable only for brackish water culture. When these soils occur as inland associations they have been very successfully used for fish culture. The organic clay and muck soils have loss on ignition figures ranging from over 20 percent to as high as 65 percent and only those with a high clay content are suitable for pond construction. The Local Alluvium soils found in many valleys have heavy textures and are very suitable for pond construction but the River Valley Alluvium Series often has very much coarser textures and is unsuitable. In Tanjong Penggerang there are extensive areas of peat soils. These soils

are not suitable for fish ponds since rapid chemical and physical erosion lead to oxygen deficiencies and to seepage of water from the ponds.

## 5. FISH CULTURE

### 5.1 General Considerations

The quantity and quality of water and land available give a great potential for fish culture development in the project area. Furthermore fish ponds can be constructed and will be productive on soils of little or no agricultural value. Most agricultural activities require a well drained soil of good physical structure and a reasonable level of natural fertility. A pond, however, is a closed system, and added fertilizers are more efficiently used than they are on land crops. With phytoplankton feeding fish there is an almost linear relationship between phosphate added and the yield of fish harvested. Indeed the traditional use of animal dung to fertilise ponds requires re-examinations. Modern research has shown that optimum results can be obtained by adding only readily soluble lime and phosphates, which are rapidly taken up in ponds. Animal dung is a complete fertilizer, rich in long term breakdown products which have beneficial effects on soil structure, and is best used on the land. By not using animal dung fish culture produces a product which is acceptable to people with religious beliefs that preclude the use of any products that have come into contact with certain animals.

### 5.2 Systems

The numerous systems of fish culture can be divided into two basic categories (1) extensive systems which rely on fertilisers to boost natural pond productivity and (2) intensive systems involving supplementary feeding.

#### 5.2.1 Extensive Systems

These systems are feasible where water and land are not limited and are especially suitable where cheap suitable livestock feedstuffs are scarce. As the water is stagnant and all food for the fish is produced from the pond itself it is necessary to have a large volume of water per fish.

It has been proved by experiment that fish stocked at a constant rate by area grow larger in large ponds and the minimum critical size is about half an acre in area. One acre is considered an ideal size and rectangular the preferred shape, with the long sides twice the length of the short sides. The pond should hold between three and four feet of

water. In order to reduce costs of construction and to facilitate pond management it is necessary to consider carefully the design and layout of ponds before construction. These aspects are discussed in the section on inputs.

The water supply can come from a river, canal or from pumped groundwater. Analyses of the fresh waters of South East Johor show them to be acid (pH 5-6.5), and as the optimum growth of fish occurs in neutral water the supply will need to be limed. Lime besides neutralising acidity provides bicarbonate ions from which aquatic plants obtain the carbon dioxide essential for photosynthesis. Research has shown that regular applications of phosphate in addition to lime are needed to fertilize freshwater ponds. Phosphate stimulates the production of blue-green algae which are capable of fixing dissolved atmospheric nitrogen. Through the activity of these algae the whole pond environment is enriched as the nitrogen fixed is passed through the food chains.

The great appeal of these systems lies in their simplicity, low operation costs and reliability. They are suitable for raising those fish which feed directly upon primary production. There are many of these fish and they are produced either as a short term crop comprising many small fish or as a longer term crop giving larger fish for consumption on special occasions.

Short term extensive pond culture: The object of this system is to raise 950 fish, most of them weighing approximately one pound in six months from stocking. Whole fish of one pound in weight are preferred for daily consumption.

Using the principles outlined above a one acre pond can be used to raise a variety of fast growing fish. A good stocking rate and mixture in Malaysia would be 600 male hybrid Tilapia mossambica, 200 Lampan Jawa (Puntius gonionotus) and 150 grass carp (Ctenopharyngodon idellus). Both the Lampan Jawa and grass carp require macrophyte water weeds to feed on once they are larger than the fingerling stage. This can be provided by culturing Hydrilla in the ponds or by supplementary feeding with grass, particularly Napier grass, and also with sweet tapioca leaves.

There are several other species which could be added in combination with these three or in substitution for one of the above. Small numbers of common carp do well in this system; if too many are stocked then they make the water very muddy in their search for food. The grouper (Trichogaster pectoralis) also does very well and is popular eating with rural people.

From 5-10 cwt lime to neutralise acidity should be added to the water at pond filling. Applications of 30 pounds of triple superphosphate should be given at the end of months one to five. After six months the pond is drained and the fish sold. With good water supplies the pond can be filled again on the same day and new fish stocked. This system yields over 1,000 one pound fish every six months. The grass carp produced will be over the one pound weight. These can be restocked, if desirable, and allowed to grow on the five or six pounds in weight.

Longer term extensive pond culture: This system is very similar to the previous one, but the fish are retained longer and therefore the fish stocked are those species with the potential to grow to a large size. The Chinese carps are very suitable and a stocking rate and mixture per acre of 200 silver carp, (Hypophthalmichthys molitrix), 200 big head carp, (Aristichthys nobilis), and 150 grass carp is recommended. The feeding habits of the species are not competitive; the silver carp feeds on phytoplankton, the big head carp are more exclusively zooplankton feeders and the grass carp feed on macrophytes cultured in the pond or on grass thrown in the pond. The presence of the grass carp is beneficial because their faeces provide an ideal substrate for the production of zooplankton, particularly forms of crustaceans. With regular monthly fertilizer application over eleven months the fish will obtain a weight of about five pounds or more giving a total production of over one ton per acre.

#### 5.2.2 Intensive systems

These systems involve boosting the pond productivity beyond the limits of natural production stimulated only by the addition of fertilizer. Their justification may be scarcity of land or water, high operating costs, or the availability of large quantities of surplus grains or protein feedstuffs which can be used as supplementary feeding. In Malaysia land and water are abundant and livestock feedstuffs are scarce; therefore intensive fish culture systems are not recommended at the present time. However, with the introduction of annual cropping, more waste grains could become available and with the development of the trawling industry, quantities of trash fish also would make suitable supplementary feeds.

The most suitable kinds of fish for supplementary feeding are those with omnivorous feeding habits. Also those fish that can withstand crowding. Of the many types of fish known as catfish, several

species make excellent subjects for intensive culture. In Thailand and neighbouring countries two species of catfish are raised by intensive methods, Clarias batrachus and Pangassius sutchi. These fish have rather different habits; the former is a short term crop of three to six months whereas the latter species takes nine to eighteen months before harvesting.

Clarias catfish require a pond with very steep or planked sides as they can climb out of a typical fish pond. The best ponds are rectangular in shape and between 100 and 1,000 square yards in size and vary in depth from three to five feet. In Thailand for a very rapid turnover fingerlings are purchased from special dealers at three to four inches in size and stocked at fifty fish per square yard of water surface. In three to four months the fish are harvested at about ten inches in size.

The fish are fed on a prepared food of varied composition, each farmer having his own recipe according to the local availability or raw materials. The main ingredients consist of meat and fish offals or trash marine fish mixed with broken rice, rice bran and peanut or maize meal. Other ingredients are added including one to provide vitamins, usually fresh papaya. The feed is chopped or minced and cooked before breaking into small pieces suitable for the fish to swallow. It is fed to the fish several times in the day particularly during the morning and evening. The conversion ratio is about 6:1.

The Pangassius catfish can obtain a weight of twenty pounds but are usually harvested at about six pounds in weight. They may be stocked in ponds with sloping sides as they cannot climb. Since they grow to a large size it is better to keep them in larger ponds, preferably one acre in area and stocked at fifteen per square yard of water surface. The fastest growing individuals are removed by periodic nettings as they attain marketable size.

Another species which because of its omnivorous diet is suitable for intensive culture is the common carp (Cyprinus carpio). This species is often raised in wooden or wire cages floating in rivers or streams, each cage supplied with food by hand. In Israel, where water is scarce, high stocking rates of common carp are achieved by artificial aeration of the water by pumping for several hours per day.

### 5.3 Extensive Fish Culture - Inputs

#### 5.3.1 Pond dimensions and construction.

The minimum size for a productive fish pond is half an acre, and it should hold between three and four feet of water. The design of a pond complex layout cannot be laid down in advance, since the shape of

the pond must be adapted to the site. The site must be planned to facilitate management and to keep maintenance to a minimum. A pond is a permanent structure and therefore extra time spent in planning the layout will save a lot of work later. If possible the layout should allow each pond to be operated independently; road access for a vehicle to each pond is also important.

In the project area many suitable sites can be found in the low lying river valleys. However there will often be a danger of localised flooding and then the outer bund of the pond complex should be specially high and an emergency deep drain constructed to take the flood water. Pond construction is made simpler on more steeply sloping sites by damming a portion of the valley. The stream or river is diverted along one side of the pond complex. Built into all ponds must be an overflow system to allow for heavy rainfall.

The best soils for the construction of fish ponds are impermeable clays. Loamy soils can be used but require compacting and may leak before sealing themselves with time. The biggest leakage of water takes place through the bunds. These therefore require careful compaction and should be stabilised by growing a short creeping species of grass on them. Trees should not be planted on the bunds as they cast shade into the water so reducing photosynthesis, and their roots can cause ponds to leak. Bunds need only be two feet above the water level and wide enough for a path along the top. They should slope on the inside of the pond at about 2 or  $2\frac{1}{2}$  to 1; the slope on the outside of the bunds can be one to one, in this way erosion will be reduced to a minimum. One bund will need to be wide enough for a vehicle to have access to the pond.

It is an advantage to have the pond bottom as even as possible and sloping towards the drain; this concentrates the fish in one place during harvesting. A shallow channel can be dug in the pond bottom which will increase this effect. To fill or empty a pond can be done very simply and cheaply by placing two pipes through the top and bottom of the bunds. These pipes must be regularly cleared as they can soon become blocked. Some leakage will occur between the pipes and the bund, but this is not likely to be important on most sites, which are likely to have a more than adequate perennial water supply. If an assumed perennial flow is not available, it may be necessary to prevent leakage by constructing an outlet sluice or monk in the bottom bund (Fig. 1). Ideally the pond should be filled and drained by gravity through a channel leading from the water supply but on very flat ground the water may have to be pumped from the source into the supply channel.

To construct a pond to hold three to four feet of water it is not necessary to excavate to this depth. Only the top eighteen inches of soil need be removed and this earth built up into bunds to contain this depth of water. Hand labour can be used for this work and one labourer will remove four cubic yards of earth per day. However the labour that will do this hard work is scarce and it is better and faster to use machinery. The costs of construction by machinery and by hand labour are similar. Complete with bunds and, if necessary, a sluice, a pond may cost about \$3,250 per acre, depending on the site and ease of access.

### 5.3.2 Water supply

A supply of unpolluted water is required to fill the pond and to replace water lost by evaporation and seepage. Only a small quantity is needed; a flow of one cusec will provide two acre-feet of water per day and most streams likely to be selected as suitable sites for fish pond development will yield far more water than this, so that quantity of water available is unlikely to be limiting.

### 5.3.3 Fertilizer application

After exhaustive experimentation in Malaysia it has been shown that only phosphate and lime of the four major nutrients need be added to fertilize freshwater ponds. Potassium is found in sufficient quantities in natural water, as a result of the run-off of the highly soluble potassium compounds from the land. Applications of nitrogenous fertilizers have greatly boosted the standing crop of phytoplankton, but usually of species largely indigestible by fish, and the use of nitrogen fertilizers is not therefore recommended.

Phosphate in the form of ~~dolomite~~ or triple superphosphate also boosts the standing crop, but in this instance the increase is of desirable species. Blooms (algal scums in surface water layers) of the blue-green group of algae appear, which are capable of fixing dissolved atmospheric nitrogen. Through the activity of these algae the whole pond environment is enriched as the nitrogen fixed is passed through the food chains, increasing the total pond productivity. Certain of these blue-green algae species are directly digestible by phytoplankton feeding fish.

Lime provides calcium, an essential constituent of all animal and plant cell walls and necessary for the process of cell division. The lime also neutralises the natural acidity, making a more favourable environment for fish life. High acidity inhibits aquatic respiration

so that most fish in such waters are adapted to breathe atmospheric oxygen. However, the main effect of the lime is to provide bicarbonate ions from which aquatic plants obtain the carbon dioxide essential for photosynthesis. Lime is commonly available in two forms, as calcium oxide, (quicklime), or calcium carbonate (limestone dust). Calcium oxide has the advantage of being highly soluble and is relatively low in bulk; calcium carbonate has twice the bulk for the same calcium content. A disadvantage of the oxide form is in its strong reaction with water, which makes it a very powerful sterilant, eliminating many useful planktonic inocula. The calcium hydroxide formed is unstable and rapidly combines with dissolved carbon dioxide to form calcium bicarbonate; some calcium carbonate is deposited reducing the water's reserves of carbon dioxide which is essential for plant growth. Limestone dust, although it has a greater bulk and lower solubility, is simple and safer to apply with less danger from an over-application. The price per pound of calcium does not give advantage to either compound. It is current practice to fertilize with 5-10 cwt of limestone dust each time the pond is filled at a cost of \$55 per ton. In a six monthly cropping cycle triple superphosphate is added at 30 pounds per acre at the end of months, 1, 2, 3, 4, and 5, a total of 150 pounds at a cost of \$25 per six months crop. The fertilizer should be placed in perforated plastic bags and tied to stakes just below the water surface at several places, so that the phosphate dissolves in the surface water layers.

#### 5.3.4 Supplementary feeding

It is considered good management practice to give supplementary food to newly stocked fry, particularly in new ponds or ponds with new water in which the natural food of fry, zooplankton, have not yet built up a large population. This food for fry must be finely divided; the food most readily available and therefore most commonly given to fry is rice bran.

This is fed at an increasing rate over a month; the precise amounts will be based on the operator's experience, probably something like:

Week I	1 lb. per day	.95 cts.
Week II	2 lb. per day	\$1.90
Week III	3 lb. per day	\$2.85
Week IV	4 lb. per day	\$3.80
		<hr/>
		\$9.50 per month 70 lbs. fed in all

Very little work has been done to find other acceptable supplementary feeds for fish fry. The analyses below suggest that both soya bean flour and fish meal flour would be more valuable than rice bran.

	Total dry matter	Total digestible protein	Total digestible nutrients	Fibre
	<u>percent</u>	<u>percent</u>	<u>percent</u>	<u>percent</u>
Soya bean flour	92.9	40.2	82.0	5.0
Fish meal flour	92.0	53.6	70.8	0.9
Rice bran	90.8	8.4	67.4	11.6

If macrophyte feeding fish are stocked it is likely that the supply of water weeds produced in the pond itself will be consumed before the fish are harvestable. For these fish supplementary feeding with leafy materials will be required and experience has shown that the best materials are young leaves of sweet tapioca varieties or young succulent grass. In practice it is easier to grow a steady supply of grass than tapioca.

Napier grass has been found to give very good results. It has a long broad leaf which fish find easy to bite, and long stems which makes it easy to hand cut and carry; also the residues are easily removed from the pond. The best variety of Napier grass is Uganda Hairless, its hairlessness making it particularly suitable for fish. Grass carp convert grass to flesh at 48:1 ratio. From the size of holding, stocking rates and stage of growth the requirement for supplementary grass feed can be determined. For example a one man 7 acre enterprise raising 600 pounds of grass carp per acre, would require up to 40 tons of Napier grass per annum. This could be produced from half an acre with intensive management.

In large ponds it is an advantage to keep the food from drifting everywhere by making a rectangle of bamboo or sticks which floats on the surface and is held in position by stakes. The food is placed in the rectangle and in this way it is possible to see whether the fish are feeding and whether more or less food is required.

### 5.3.5 Position of site and fencing

The pond site should if possible be near the operator's house. If it is not there is always danger of fish being stolen or eaten by otters and birds. In addition when the house is close by the ponds, there is less chance that welfare of the fish will suffer due to neglect.

It is almost essential to fence the pond area to keep out domestic and predatory animals. A good fence can be made from diamond mesh or chicken wire netting of  $2\frac{1}{2}$ -3 inches mesh and four to six feet wide. The netting is buried 4 to 6 inches in the ground and bent outwards at the top. The netting is supported by poles buried  $1\frac{1}{2}$  feet in the ground.

#### 5.4 Schemes

The popular idea of fish culture is at a subsistence level whereby each rural dweller has in his backyard a few square yards of pond. Into this pond all household refuse is thrown and in return the household enjoys occasional meals of fish. This system has very little to recommend it, as the returns are very low because of the small size of the pond and the unsuitability of most of the material put in the pond. These small household ponds do not have the capacity to give good yields and operators become disillusioned with the whole business of pond culture. A better use of resources and the extension service is achieved if fish culture is in the hands of fewer specialist operators.

Extensive fish culture systems are widely practised in West Malaysia. The traditional system involves fertilizing the pond with animal manure. Pig and poultry manures are better than cattle manure because of their lower bulk and higher nutrient content. However none are as satisfactory as mineral fertilisers. A one-acre pond can usefully use 500-1,000 pounds of pig manure, or 100-200 pounds of poultry manure, per week. Thus considerable clearing out of the pond bottom will be required after each harvest. Dung should not be used in fish ponds except where these offer the only useful place for disposal of manure from livestock enterprises on the same farm.

The use of phosphate fertilizer alone permits great savings in labour and these can be used to operate a larger number of ponds. With casual labour for harvesting and some part time assistance from a family member one man can operate 7-10 acres of ponds.

The extensive fish culture system using inorganic fertilizers is very simple in terms of technical knowledge required and its adaptability gives it much appeal to rural developers. With a suitable site and water supply a viable unit can be as small as half an acre operated as a part time enterprise up to 10 acres which is a full time occupation for one man. Certain other enterprises, for example rubber growing and vegetable production, can be combined with fish culture very successfully. Smallholder rubber operators often have time during the day when they are unoccupied and could spend this time in pond management. Vegetable farmers can feed the waste leaves of vegetables to the fish and after the fish

are harvested a vegetable crop can be grown in the pond mud or some of the mud can be removed and used on the vegetable beds.

Fish culture can also fit into many different types and levels of organisation. With the general trend of lower profits from rubber and oil palm many private estates are making better use of their waste land. Much of this waste land is marshy valley bottoms which have been usefully converted into fish ponds. The fish from these ponds is sold to the estate workers. Fish culture could be an excellent way to boost the incomes of settlers on public sector schemes. Initially it might be preferable if the production from these ponds were sold on the schemes but later any regular surplus might be disposed of through a co-operative which could transport and sell the fish in neighbouring towns. As the returns to fish culture start very early, (6 months after stocking), fish culture could provide a useful income in the early days of the settlement when it is most needed.

Fish culture is particularly suitable for adoption in public sector schemes, where the management can finance and supervise the pond construction and watch over the subsequent operation of the ponds.

#### 5.5 Economics of Fish Culture

Whether the short term or longer term extensive system of culture is adopted will depend on the operator's situation and his intended market. In rural villages, on estates and on F.L.D.A. schemes the demand is for small whole fish not more than one pound in weight. In the town the demand is for larger fish which will be produced on the longer term system. A prospective farmer should appraise operating expenses and methods and, most important, the frequency of cash returns before deciding on which system to adopt. For comparison both the short and long term systems have been evaluated, on the basis of one-man operated 7 acre schemes. Both schemes are profitable but the long term one particularly so. However the risks involved in the latter are also very much greater. At the initial stocking the china carp fry have to be bought from dealers who import the fry from China. It often happens that the fry are parasitised and weakened by the journey so that mortality can be high, making purchase of replacements necessary. Another risky period is at harvest time. The pond will be full of large sized fish whose oxygen requirement will be close to the maximum oxygen content of the water. Over fertilization or adverse weather conditions at this time can result in rapid deoxygenation of the water with mass fish mortality. The short term extensive system is nothing like so vulnerable.

One man working full time can operate seven acres of ponds with casual labour at harvest time. With some part-time assistance from a member of his family one man could easily operate ten acres of ponds. The two schemes evaluated are based on the same extensive fish culture techniques, but the length of the cycle of operation and the kinds of fish raised are different. In both schemes the ponds are stocked and harvested in sequence at monthly intervals. The short term crop is harvested after six months, the long term crop after one year.

The costs of the long-term extensive system are set out in Table 6 and those of the short-term system in Table 11. The following explanatory notes on individual cost items apply to both tables.

Land clearance: The costs of land clearance would in practice be part of one operation with pond construction. This would give a lower cost in total; for simplicity the costs for clearance and construction are given separately.

Pond construction: At present the cost of pond construction by contractors is rather high, as the contractors have little experience and regard the undertaking as risky. This puts a premium on the contract price. With planning, pond construction could be carried out by the contractors who clear the jungle and build the roads. The same machinery could be used and some savings in cost made. The cost includes provision of a sluice, which will often be unnecessary.

Buildings: It is advisable for the pond operator to live near the pond complex, so reducing the opportunities for theft. The only building required for operation of the ponds is a room for the storage of tools, nets, and fertilizers; this can be cheaply built as an extension to the operator's home.

Establishment of grass: As high yields (40 tons per  $\frac{1}{2}$  acre) of high quality grass are required it is important that proper establishment in clean soil is made with regular replanting.

Farm yard manure: Cow dung may be used, but only in new ponds.

Fish fry: This is a major item of cost with the long term system raising china carp as all the fish fry have to be purchased. It is hoped that the government will set up a station to breed china carp and sell them more cheaply than the imported fry. The fry for the short term mixed stocking system are supplied free from the government. How long this will continue to be the policy is not known so in the analysis a nominal charge for fry has been made.

Operators' labour: This cost is made up of a daily wage to the operator of \$4.75 and he works six days per week.

Casual labour: Casual labour is required to help with the harvesting of the ponds; this would usually be some member of the operator's family. Should this help not be available then \$4 would hire two labourers for two hours which is sufficient time to net a pond and load the catch into a truck.

5.5.1 Scheme I. The longer term extensive system, raising China carp.

Four situations are examined. In all of them stocking rates are identical and ponds are harvested one year after stocking. The costs (Table 6) are also the same for all situations.

Situation A In this situation very good management has been assumed and favourable farm gate prices.

Annual yields and returns per acre are as follows:

200 Big Head carp @ 4 katis each @ \$1 per kati	=	\$ 800
200 Silver carp @ 6 katis each @ \$0.75 per kati	=	900
150 Grass carp @ 4 katis each @ \$0.85 per kati	=	510
		<hr/>
		\$2210

Situation B The yields assumed are as in situation A, but the farm gate price has been taken at 20 cents per kati cheaper for all fish. This reduces the return by \$520 per acre.

Situation C A somewhat lower level of management has been assumed. Under normal commercial conditions some losses will inevitably occur, and yields are assumed to be 10 percent lower than in the previous situations. Farm gate prices as in Situation B are assumed.

Situation D This assumed that yields are only half those obtained in Situation A. This could result from a scarcity of fry reducing the stocking rate, from serious disease and from general poor management. The farm gate price has been assumed to be as in Situation A.

The gross receipts resulting from these four situations are given in Table 7, and the net cash flows and internal rates of return in Table 8. The operator's monthly net cash receipts for the four situations are shown in Table 9. These exclude the charge for the operator's own labour. Thus an owner operator would receive the monthly cash income shown in this table plus approximately \$124 per month for

TABLE 6 Scheme I Costs (\$), With and Without Cost of Operator's Labour

Year	Land Clearance	Pond Construction & Repairs	Building & Repairs	Establish grass & Reestablish	Fertilizers for grass	Fertilizers for pond	Farm Yard Manure	Fish Fry	Lime	Fry Food	Labour Operator	Labour Casual	Tools	Fish Net	Sprays & Poison	Total Costs	Costs (Excluding Operator's Labour)
1	1,300	24,500	200	60	110	294	120	1,665	440	85	1,482	12	200	400	5	30,873	29,391
2	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
3	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
4	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
5	-	2,450	20	40	110	368	-	1,665	248	85	1,482	36	100	40	5	6,649	5,167
6	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
7	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
8	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
9	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
10	-	2,450	-	-	110	368	-	1,665	248	85	1,482	36	100	400	5	6,989	5,507
11	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
12	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
13	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
14	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
15	-	2,450	20	40	110	368	-	1,665	248	85	1,482	36	100	40	5	6,649	5,167
16	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
17	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
18	-	-	-	-	110	368	-	1,665	248	85	1,482	36	-	-	5	3,999	2,517
19	-	-	20	-	110	368	-	1,665	248	85	1,482	36	-	-	5	4,019	2,537
20	-	2,450	-	40	110	368	-	1,665	248	85	1,482	36	100	400	5	6,989	5,507
																<u>118,274</u>	
NPV at 15%	1,300	27,116	258	103	794	2,574	120	11,987	1,976	612	10,666	237	306	571	36	58,656	
Percent of NPV of Total Costs	2.22	46.23	0.44	0.18	1.35	4.39	0.20	20.45	3.37	1.04	18.18	0.40	0.52	0.97	0.06	100.0	

TABLE 7 SCHEME I GROSS RECEIPTS (\$) AT DIFFERENT PRICE AND YIELD LEVELS

Year	A High Yields High Prices	B High Yields Price Down	C Good Yields Down 10% Price down 20Octs/kati	D Poor Management Yields downs 50 Percent High Price
1	-	-	-	-
2	15,470	11,830	10,647	7,735
3	15,470	11,830	10,647	7,735
4	15,470	11,830	10,647	7,735
5	15,470	11,830	10,647	7,735
6	15,470	11,830	10,647	7,735
7	15,470	11,830	10,647	7,735
8	15,470	11,830	10,647	7,735
9	15,470	11,830	10,647	7,735
10	15,470	11,830	10,647	7,735
11	15,470	11,830	10,647	7,735
12	15,470	11,830	10,647	7,735
13	15,470	11,830	10,647	7,735
14	15,470	11,830	10,647	7,735
15	15,470	11,830	10,647	7,735
16	15,470	11,830	10,647	7,735
17	15,470	11,830	10,647	7,735
18	15,470	11,830	10,647	7,735
19	15,470	11,830	10,647	7,735
20	15,470	11,830	10,647	7,735

TABLE 8

## Scheme I Net Cash Flows (\$)

Year	Situation			
	A	B	C	D
1	-30,837	-30,837	-30,837	-30,837
2	11,471	7,841	6,648	3,736
3	11,451	7,811	6,628	3,716
4	11,471	7,831	6,648	3,736
5	8,821	5,181	3,998	1,086
6	11,471	7,831	6,648	3,736
7	11,451	7,811	6,628	3,716
8	11,471	7,831	6,648	3,736
9	11,451	7,811	6,628	3,716
10	8,481	4,841	3,658	746
11	11,451	7,811	6,628	3,716
12	11,471	7,831	6,648	3,736
13	11,451	7,811	6,628	3,716
14	11,471	7,831	6,648	3,736
15	8,821	5,181	3,998	1,086
16	11,471	7,831	6,648	3,736
17	11,451	7,811	6,628	3,716
18	11,471	7,831	6,648	3,736
19	11,451	7,811	6,628	3,716
20	8,481	4,841	3,658	746
Internal Rate of Return	36%	24%	19%	8%

TABLE 9 Scheme I Operator's Monthly Net Cash Receipts (\$)  
After Loan Repayment At 10% Per Annum  
(Excluding Operator's Labour)

Year	Situations			
	A	B	C	D
1	-	-	-	-
2	613	314	216	-29
3	611	313	214	-31
4	613	314	216	-29
5	392	94	-5	-250
6	613	314	216	-29
7	611	313	214	-31
8	613	314	216	-29
9	611	313	214	-31
10	364	65	-33	-279
11	611	313	214	-31
12	613	314	216	-29
13	611	313	214	-31
14	613	314	216	-29
15	392	94	-5	-250
16	613	314	216	-29
17	949	651	552	307
18	951	653	554	309
19	949	651	552	307
20	702	403	305	60
Annual Repayment	4,059	4,059	4,059	4,059

TABLE 10

Scheme I. Sales, Costs and Returns on Seven-Acre  
Enterprise With Good Yields and Falling Prices

Year	Gross Sales (\$)	Costs (\$)	Net Cash Flow (\$)
1	-	30,873	-30,873
2	13,869	3,999	9,870
3	13,465	4,019	9,446
4	13,073	3,999	9,074
5	12,692	6,649	6,043
6	12,322	3,999	8,323
7	11,963	4,019	7,944
8	11,615	3,999	7,616
9	11,277	4,019	7,259
10	10,948	6,989	3,959
11	10,647	4,019	6,628
12	10,647	3,999	6,648
13	10,647	4,019	6,628
14	10,647	3,999	6,648
15	10,647	6,649	3,998
16	10,647	3,999	6,648
17	10,647	4,019	6,628
18	10,647	3,999	6,648
19	10,647	4,019	6,628
20	10,647	6,989	3,658

Internal Rate of Return 27%

his own labour, if he were paying off the capital invested at 10 percent in 15 equal annual instalments.

In Situation A the fish enterprise is extremely profitable, yielding an internal rate of return over 35 percent on the capital invested, and providing on owner-operator with an income of at least \$700 per month after meeting loan repayments.

A number of private interests are displaying interest in this type of fish culture. A fairly rapid increase in production would result in a decline in price for these fish. Situation B determines returns assuming prices 20 cents per kati lower than in A. Returns are reduced to 24 percent. A reduction in yield by 10 percent at this price level, which might be expected under average management, lowers the return further to about 19 percent. Since entry to this industry is relatively easy - given ability to raise the necessary capital - it is reasonable to expect that competition will reduce returns to this level or perhaps slightly lower. Table 10 shows the value of sales of an average enterprise starting in the near future as the industry expands and product prices fall. Prices are assumed to fall from the current level, as in Situation A, to those in Situation B over 10 years, or approximately 2 percent per year. This enterprise is also expected to attain average yields as in Situation C. On these assumptions the rate of return is still high at 27 percent.

In general the profitability of freshwater fish culture is less sensitive to changes in yield than pigs or poultry. However under poor management (Situation D) returns are poor (8 percent) even at attractive prices. If the yields in Situation D occurred at the prices assumed in Situation B the return would fall to zero.

#### 5.5.2 Scheme II. Short-term extensive system, raising small fish

The itemised costs of this scheme are set out in Table 11. Two levels of cost are shown, one in which the Tilapia and Lampan Jawa fry are assumed to be free, and one in which a nominal charge of 5 cents each is made.

The ponds are assumed to be harvested six months after stocking and to yield as follows per acre:

600 Hybrid tilapia @ 1 kati each @ 50 cents per kati	farm	= \$300
	gate	
200 Lampan Jawa @ 1 kati each @ 50 cents per kati	farm	= 100
	gate	
150 Grass carp @ 3 katis each @ 75 cents per kati	farm	= 337.50
	gate	
		<u>737.50</u>

TABLE 11 Scheme II Costs (\$) Including Cost of Operator's Labour

Year	Land Clearance	Pond Construction & Repair	Buildings	Establish grass	Fertilizer for grass	Fertilizer for ponds	Fish Fry Free and G. Carp @ 30 cts.	Fish Fry 5 cents each and G. Carp @ 30 cts.	Lime	Fry Food	Operator's Labour	Casual Labour	Nets, Tools	Sprays Poison	F.Y.M.	Total Costs
1	1,300	24,500	200	60	110	338	630	1,190	385	133	1,482	-	600	5	120	30,423
2	-	-	-	-	110	343	630	1,190	385	133	1,482	48	-	5	-	3,696
3	-	-	20	-	110	358	405	.765	248	86	1,482	48	-	5	-	3,122
4	-	-	-	-	110	363	540	1,020	330	114	1,482	48	-	5	-	3,812
5	-	2,450	20	40	110	343	630	1,190	385	133	1,482	48	140	5	-	6,346
6	-	-	-	-	110	343	495	.935	302	105	1,482	48	-	5	-	4,336
7	-	-	20	-	110	343	450	.850	275	95	1,482	48	-	5	-	3,228
8	-	-	-	-	110	338	630	1,190	385	133	1,482	48	-	5	-	3,691
9	-	-	20	-	110	343	630	1,190	385	133	1,482	48	-	5	-	3,716
10	-	2,450	-	40	110	358	405	.765	248	86	1,482	48	500	5	-	6,092
11	-	-	20	-	110	363	540	1,020	330	114	1,482	48	-	5	-	3,492
12	-	-	-	-	110	343	630	1,190	385	133	1,482	48	-	5	-	3,696
13	-	-	20	-	110	343	495	.935	302	105	1,482	48	-	5	-	3,350
14	-	-	-	-	110	343	450	.850	275	95	1,482	48	-	5	-	3,208
15	-	2,450	20	40	110	338	630	1,190	385	133	1,482	48	140	5	-	6,341
16	-	-	-	-	110	343	630	1,190	385	133	1,482	48	-	5	-	3,696
17	-	-	20	-	110	358	405	.765	247	86	1,482	48	-	5	-	3,121
18	-	-	-	-	110	363	540	1,020	330	114	1,482	48	-	5	-	3,472
19	-	-	20	-	110	343	630	1,190	385	133	1,482	48	-	5	-	3,716
20	-	2,450	20	40	110	343	495	.935	302	105	1,482	48	500	5	-	6,320
NPV AT 15% (fry charged)	1,300	27,116	258	100	794	2,500		7,513	2,432	840	10,666	360	877	36	120	54,612
Percent of NPV of Total Costs	2.37	49.39	0.46	0.18	1.44	4.56		13.69	4.43	1.53	19.43	0.65	1.60	0.06	0.21	100
NPV AT 15% (fry free)	1,300	27,116	258	100	794	2,500	3,977		2,432	840	10,666	360	877	36	120	54,612
Percent of NPV of Total Costs	2.53	52.78	0.50	0.19	1.54	4.87	7.75		4.74	1.63	20.77	0.70	1.70	0.07	0.23	100

The ponds are assumed to be stocked and harvested successively, permitting 12 acres to be harvested annually. Table 12 shown the total costs, sales, net cash flow and internal rate of return, and Table 13 the operator's monthly cash receipts, exclusive of his labour.

TABLE 12 Scheme II Total Costs, Sales and Net Cash Flow (\$)

<u>Year</u>	<u>Total Cost</u>	<u>Total Sales</u>	<u>Net Cash Flow</u>
1	30,423	..	-30,423
2	3,696	8,850	5,154
3	3,122	8,850	5,728
4	3,812	8,850	5,038
5	6,346	8,850	2,504
6	4,336	8,850	4,514
7	3,228	8,850	5,622
8	3,691	8,850	5,159
9	3,716	8,850	5,134
10	6,092	8,850	2,758
11	3,492	8,850	5,358
12	3,696	8,850	5,154
13	3,350	8,850	5,500
14	3,208	8,850	5,642
15	6,341	8,850	2,509
16	3,696	8,850	5,154
17	3,121	8,850	5,729
18	3,472	8,850	5,378
19	3,716	8,850	5,134
20	6,320	8,850	2,530

Internal Rate of Return 15%

The return of 15 percent on this type of production at assumed cost, yield and price levels is much below that for the speciality carp enterprise analysed earlier. It is therefore expected that unless techniques are improved prices are unlikely to fall below present levels. As a subsidiary enterprise for a smallholder or as an adjunct to land development schemes it is still reasonably attractive and as noted earlier in the paper provides a valuable and popular source of animal protein which is normally not freely available in rural areas.

TABLE 13

Scheme II. Operator's Monthly Cash Receipts  
(Excluding Operator's Labour)

Year	Monthly Cash Receipts
1	-2535
2	96
3	144
4	87
5	-125
6	43
7	135
8	97
9	95
10	-104
11	113
12	96
13	125
14	137
15	-124
16	96
17	477
18	448
19	428
20	211
Annual Repayment	4,000

## 6 POSSIBLE SITES

The actual site selection depends on many factors such as soil and water supply which have already been discussed. Water supply is the key to site selection and it is difficult to predict what will happen to stream flow when the jungle is cleared and the land developed. The sites named below and shown on the Development Plan are known to have suitable soil and reasonable slope. Whether they are selected for development will depend on their proximity to centres of population, the quantity of water in them after land clearance and their freedom from possible sources of pollution such as rubber or oil palm factories.

In Johor Tengah some reaches of the S. Sembrong and some tributaries of the S. Kahang flow through wide valleys filled with Local Alluvium soils and contain many potential fish pond sites. Certain reaches of the S. Penggeli and S. Jengli also have many suitable sites.

Tanjong Penggerang is characterised by a great number of streams supported by relatively small catchments and flow conditions in these streams are likely to be more erratic after development. Salt water intrusion also renders many otherwise suitable valleys unfit for fish ponds. The S. Sedili Kechil has wide valleys which because of localised flooding are unsuitable for agriculture but highly suitable for fish culture.

All the sites mentioned have good soils for pond construction. However, there will be many other sites on other soils which will be equally suitable, if the quantity and quality of the water can be assured.

## 7 STOCKING OF RESERVOIRS

Three reservoirs have been proposed for the conservation of future supplies of water for drinking and industrial uses. Following the initial inundation, particularly if the land is previously burnt, nutrient salts may be released from the inundated land. This nutrient enriched water is an excellent medium for the growth of dense masses of algal blooms, which can lower water quality by tainting and so increase the costs of purification.

Control of these blooms by algicides is expensive and applications have to be repeated to prevent recovery. An attractive method of control is to stock the reservoirs with phytoplankton feeding fish before the nutrient level of the water is high enough to support algal growth. These fish live on diatoms and forms of life that grow at lower nutrient levels than algal blooms. The removal of the diatoms reduces the nutrient levels in the waters, so preventing invasion by algae.

The most suitable species of phytoplankton feeding fish for stocking reservoirs are Tilapia nilotica and Tilapia mossambica, both of which breed well and maintain their numbers against predatory fish such as Ophiocephalus spp. which will enter the reservoirs from streams and rivers. The silver carp, Hypothalmicthys molitrix, is also an excellent phytoplankton feeder and grows very rapidly to a large size, but as it would be unlikely to breed in the reservoir, its maintenance will demand outside stocking. This would probably be uneconomic in large bodies of water where it would be difficult to recover a high percentage from fishing, although the species can be caught in gill nets. Furthermore, stocking of reservoirs is a complex procedure and, as each reservoir is a unique situation, rigid guidelines must not be laid without on-site investigations of the conditions.

Either adult fish or fish of not less than six inches in length should be used for stocking. Such fish may be obtained in large numbers from nearby padi fields, converted into fish ponds for six months and stocked with fry from a multiplication station. Alternatively the fry may be stocked in existing fish ponds on a contract basis or in return for certain fishing rights in the reservoir.

## 8 FISH PRESERVATION AND MARKETING

Fish is a highly perishable commodity, and will require preservation when the supply to the market is in excess of immediate demand or when the market is far from the source of supply. Fish may be preserved in many ways; salted, smoked, fried, iced, frozen, canned or turned into fish powder. In Malaysia the usual methods are icing for temporary preservation and salting and drying for long term preservation. It is only necessary to consider drying and salting for marine fish which are landed in large quantities. Usually the harvesting of freshwater fish can be so arranged that they are sold fresh or if sale is delayed temporarily preserved by icing.

Ice factories are found throughout Malaysia and the quantities of ice required to send a load of fish to market are readily available. Iced fish must be transported in insulated containers; shaved or crushed ice is preferable to blocks and chunks of ice. At least twice the weight of ice is required compared to the weight of fish to be preserved. If storage is required for up to 24 hours the fish need no preparation other than packing in ice. If longer preservation is required then the fish must be gutted and have their gills removed. Bacterial action is slowed down but not stopped by ice. Well packed fish can be kept on ice for two

to three weeks. If longer storage is required then the fish must be frozen.

At present time fish is bought from the pond operator at the farm gate and transport costs are borne by the middleman. Where possible, such as on F.L.D.A. schemes, it could be financially advantageous for the operators to market their own fish through a co-operative system.

APPENDIX  
HOUSEHOLD EXPENDITURE SURVEY - FISH

1 INTRODUCTION

A survey was carried out in South Johor during April 1970 aimed at providing background information on expenditure of Malaysian consumers on food items, particularly meats, fish and dairy products which were being investigated as possible production activities in the Project Area. A total of 1,863 households were interviewed, 1,214 Malays, 529 Chinese and 120 Indians.

The results of this survey with respect to fish products have been summarised where appropriate in the main paper. This appendix tabulates the detailed results indicating expenditure per household on different fish products within each racial group and also the frequency of purchase of the major items.

All Fish Consumption

Since fresh fish is a highly perishable commodity it is normally eaten on the same day as it is purchased. Frequency of purchase is therefore a reasonably good measure of frequency of consumption. As is generally known fish is one of the staple items in the Malaysian diet, especially in areas such as South Johor which are near the coast and where supplies are normally plentiful. As shown in Tables A.1 and A.2 approximately 75 percent of Malay households and 72 percent of Chinese households indicated that they bought fish daily. A further 18 percent of Malays and 22 Chinese said that they bought two to three times per week. Indian households were somewhat less frequent consumers 29 percent buying daily and 50 percent two or three times per week.

Table A.4 shows the estimated average monthly expenditures on the different types of fish, by households in the three racial groups, cross classified by income groups. Since the figures are based upon the respondent's estimates at the time of interview, the stated expenditure on individual items does not necessarily add to the stated total expenditure. For this reason results should be interpreted with a degree of caution. However, they do broadly agree with what might be expected. While fish products as a whole are an extremely important item of the diet at lower income levels the proportion of income spent on them falls with rising incomes, i.e. the income elasticity of demand is less than one (it appears from this data to be about 0.4).

Looking at the individual items, expenditure on dried fish and dried prawns does not generally speaking rise with higher incomes. This may be because those with higher incomes have the money or time to make more frequent trips to market or just that it is easier to use the dried products in small quantities. Expenditure on items such as fresh prawns, crabs and cuttle fish rise much more rapidly with higher incomes.

The remainder of the tables give detailed figures on reported household expenditure on the individual items, broken down by racial and income groups.

TABLE A.1      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FISH PRODUCTS - MALAYS

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	132	347	160	169	100	908
Twice or thrice per week	51	103	28	20	13	215
Weekly	34	18	4	1	-	57
Forthnightly	7	1	1	-	-	9
Monthly	3	3	-	1	-	7
Occasionally	5	4	-	-	-	9
Never	1	6	1	-	1	9

TABLE A.2      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FISH PRODUCTS - CHINESE

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	6	109	116	90	47	368
Twice or thrice per week	4	37	35	19	15	110
Weekly	2	7	4	-	1	14
Forthnightly	-	-	-	-	-	-
Monthly	1	-	-	-	-	1
Occasionally	3	4	-	1	1	9
Never	3	-	-	-	2	5

**TABLE A.3** NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FISH - INDIANS

<u>Frequency</u>	<u>Less than</u>	<u>\$100-</u>	<u>\$200-</u>	<u>\$300-</u>	<u>\$500 and</u>	<u>Total</u>
	<u>\$100</u>	<u>199</u>	<u>299</u>	<u>499</u>	<u>over</u>	
Everyday	1	15	5	6	8	35
Twice or thrice per week	2	23	10	10	14	59
Weekly	1	12	5	2	-	20
Forthnightly	-	-	1	2	-	3
Monthly	-	-	-	-	-	-
Occasionally	-	-	-	-	2	2
Never	-	-	-	-	1	1

**TABLE A.4** AVERAGE MONTHLY EXPENDITURES PER HOUSEHOLD BY MONTHLY INCOME AND TYPE OF FISH PRODUCT

<u>Type of Product</u>	<u>Monthly Income Group</u>				
	<u>\$0-99</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 &amp; over</u>
<b>(a) Malays</b>					
All Fish	16.70	26.73	38.16	45.82	60.2
Fresh Sea Fish	10.20	17.71	24.66	29.59	33.45
Dried Fish	2.45	4.16	2.52	2.16	2.96
Freshwater Fish	0.35	0.33	0.33	0.34	3.24
Crabs	0.34	0.60	0.83	1.24	2.27
Fresh Prawns	1.32	2.59	3.83	4.66	5.29
Dried Prawns	0.56	0.81	1.06	1.64	1.90
Cuttle Fish	0.86	1.26	1.99	1.98	3.00
<b>(b) Chinese</b>					
All Fish	19.34	28.81	37.97	41.75	47.50
Fresh Sea Fish	15.95	21.41	25.92	28.92	28.36
Dried Fish	0.67	1.18	1.93	1.52	1.56
Freshwater Fish	0.12	0.53	0.69	0.41	0.64
Crabs	0.39	0.59	1.29	1.08	2.15
Fresh Prawns	0.98	2.25	2.97	3.63	4.84
Dried Prawns	0.51	0.73	0.92	1.04	1.00
Cuttle Fish	0.44	0.66	1.33	1.27	1.48
<b>(c) Indians</b>					
All Fish	23.75	25.25	23.7	33.3	46.3
Fresh Sea Fish	15.0	21.1	23.1	21.7	28.7
Dried Fish	1.81	2.53	2.34	1.70	1.72
Freshwater Fish	1.30	0.30	0.20	0.10	0.15
Crabs	0.25	1.24	2.71	1.37	3.35
Fresh Prawns	2.06	3.72	3.07	4.46	6.42

cont.

Dried Prawns	0.59	0.50	0.67	1.06	0.69
Cuttle Fish	0.12	0.66	1.91	1.33	1.45

TABLE A.5      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON ALL FISH - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 4.99	51	19	1	2	2
5 - 9.99	44	56	8	7	1
10-19.99	69	143	29	20	8
20-29.99	28	107	46	32	16
30-39.99	14	66	33	29	12
40-49.99	10	36	28	25	11
50-59.99	4	18	15	20	8
60-79.99	2	19	21	31	20
80-90.99	3	6	3	12	13
\$100 +	1	7	7	10	20
Not clear	7	4	3	2	3

TABLE A.6      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON ALL FISH-GHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 4.99	6	12	3	3	1
5 - 9.99	3	12	7	3	6
10 - 19.99	2	36	22	10	7
20 - 29.99	1	26	32	11	6
30 - 39.99	3	37	34	24	15
40 - 49.99	1	14	24	22	7
50 - 59.99	1	7	7	16	6
60 - 79.99	1	9	18	11	8
80 - 90.99	-	3	5	6	5
\$100 +	-	-	3	1	5
Not clear	1	1	-	3	-

TABLE A.7      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON ALL FISH-INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 4.99	-	1	-	-	3
5 - 9.99	-	10	3	-	2
10 - 19.99	1	12	4	5	1
20 - 29.99	2	11	5	5	5
30 - 39.99	-	5	2	4	3
40 - 49.99	-	4	3	-	1
50 - 59.99	-	3	2	4	1
60 - 79.99	1	3	1	2	4
80 - 90.00	-	-	-	-	3
\$100 +	-	-	-	-	2
Not clear	-	1	1	-	-

TABLE A.8      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FRESH SEA FISH - MALAYS

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	83	277	133	144	82	717
Twice or thrice per week	59	145	47	35	22	308
Weekly	42	25	7	5	9	88
Forthnightly	8	6	3	2	-	19
Monthly	15	9	1	-	-	25
Occasionally	9	6	-	2	1	18
Never	17	13	3	3	-	36

TABLE A.9      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FRESH SEA FISH - CHINESE

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	7	4	111	80	39	241
Twice or thrice per week	4	32	36	21	16	109
Weekly	3	10	7	1	7	28
Forthnightly	1	3	1	1	1	7
Monthly	1	-	-	-	1	2
Occasionally	2	5	-	1	1	9
Never	1	3	-	6	1	11

TABLE A.10      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY  
OF PURCHASE OF FRESH SEA FISH - INDIANS

<u>Frequency</u>	<u>Less than</u> <u>\$100</u>	<u>\$100-</u> <u>199</u>	<u>\$200-</u> <u>299</u>	<u>\$300-</u> <u>499</u>	<u>\$500 and</u> <u>over</u>	<u>Total</u>
Everyday	1	10	6	5	5	27
Twice or thrice per week	2	25	8	11	11	57
Weekly	1	15	5	3	5	29
Forthnightly	-	-	2	1	-	3
Monthly	-	-	-	-	-	-
Occasionally	-	-	-	-	2	2
Never	-	-	-	-	1	1

TABLE A.11      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON FRESH SEA FISH - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0- 2.49	59	23	3	6	1
2.5- 7.49	49	58	17	9	5
7.5-12.49	42	121	23	12	7
12.5-17.49	16	59	18	11	12
17.5-22.49	24	70	35	26	11
22.5-27.49	7	53	24	20	9
27.5-32.49	9	21	21	24	11
32.5-37.49	6	23	13	14	5
37.5-44.99	-	9	6	9	6
45 or over	5	32	32	55	47
No Answer	16	12	2	2	-

TABLE A.12      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON FRESH SEA FISH - CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0- 2.49	4	12	4	1	-
2.5- 7.49	2	18	7	5	6
7.5-12.49	3	15	20	7	8
12.5-17.49	3	22	17	7	4
17.5-22.49	-	13	14	9	7
22.5-27.49	1	13	18	9	4
27.5-32.49	3	39	39	30	12
32.5-37.49	-	4	9	5	2
37.5-44.99	-	-	1	4	3
45 or over	2	18	26	27	18
No Answer	1	3	-	6	1

TABLE A.13      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON FRESH SEA FISH - INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0- 2.49	-	-	2	-	1
2.5- 7.49	-	18	4	2	2
7.5-12.49	3	9	1	8	3
12.5-17.49	-	6	2	1	4
17.5-22.49	-	7	4	1	2
22.5-27.49	-	3	2	2	-
27.5-32.49	1	1	1	2	-
32.5-37.49	-	4	-	-	-
37.5-44.99	-	-	2	-	1
45 or over	-	2	3	4	10
No Answer	-	-	-	-	1

TABLE A.14      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON DRIED FISH - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	19	34	10	17	13
0.25 - 0.49	21	17	10	11	3
0.50 - 0.99	28	65	23	20	14
1.00 - 1.49	30	87	27	26	15
1.50 - 1.99	22	64	17	22	9
2.00 - 2.49	21	52	23	17	9
2.50 - 3.49	21	41	20	27	8
3.50 - 4.99	20	33	23	12	13
5.00 - 7.49	10	25	22	15	10
Over 7.50	24	29	7	11	15
No Answer	17	34	12	13	5

TABLE A.15      NUMBER OF HOUSEHOLDS BY INCOME GROUP MONTHLY EXPENDITURE PER HOUSEHOLD ON DRIED FISH-CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	2	39	20	12	10
0.25 - 0.49	2	6	9	5	5
0.50 - 0.99	1	21	19	19	6
1.00 - 1.49	1	10	19	12	4
1.50 - 1.99	-	8	7	5	3
2.00 - 2.49	2	15	16	13	5
2.50 - 3.49	-	2	9	5	7
3.50 - 4.99	1	6	7	7	5
5.00 - 7.49	-	1	4	1	3
Over 7.50	-	7	6	5	1
No Answer	10	42	39	25	17

TABLE A.16      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON DRIED FISH - INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	-	1	-	2	2
0.25 - 0.49	-	-	1	-	1
0.50 - 0.99	1	2	2	2	2
1.00 - 1.49	1	14	4	3	3
1.50 - 1.99	-	4	3	3	1
2.00 - 2.49	1	7	2	2	3
2.50 - 3.49	1	2	2	1	3
3.50 - 4.99	-	5	2	2	1
5.00 - 7.49	-	2	-	-	1
Over 7.50	-	5	2	1	1
No Answer	-	8	3	4	7

TABLE A.17      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FRESH WATER FISH - MALAYS

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	-	-	2	-	-	2
Twice or thrice per week	3	4	1	1	1	10
Weekly	2	5	1	2	1	11
Forthnightly	2	5	-	-	2	9
Monthly	1	3	1	4	4	13
Occasionally	20	45	13	13	8	99
Never	205	419	176	171	98	1069

TABLE A.18      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FRESH WATER FISH - CHINESE

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	-	-	1	-	-	1
Twice or thrice per week	-	2	3	1	1	7
Weekly	-	5	2	1	-	8
Forthnightly	-	5	6	6	2	19
Monthly	-	-	2	3	1	6
Occasionally	-	21	19	10	6	56
Never	19	124	122	89	56	410

TABLE A.19      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND FREQUENCY OF PURCHASE OF FRESH WATER FISH - INDIANS

<u>Frequency</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>	<u>Total</u>
Everyday	1	-	-	-	-	1
Twice or thrice per week	-	2	-	-	-	2
Weekly	-	1	-	-	-	1
Forthnightly	-	-	1	1	1	3
Monthly	-	-	-	-	1	1
Occasionally	1	8	-	-	4	13
Never	2	39	20	19	19	99

TABLE A.20      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON FRESH WATER FISH-MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	18	39	10	6	9
0.5 - 0.74	2	5	1	5	1
0.75 - 0.99	1	-	1	3	-
1.0 - 1.49	1	3	2	2	3
1.50 - 1.99	1	3	-	-	1
2.00 - 2.49	1	2	2	1	1
2.50 - 2.99	1	1	-	-	-
3.00 - 3.99	-	2	-	-	1
4.00 - 4.99	-	2	1	1	-
Over 5.00	3	2	1	1	-
No Answer	205	422	176	172	98

TABLE A.21      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON FRESH WATER FISH-CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	-	17	12	5	4
0.5 - 0.74	-	2	3	4	1
0.75 - 0.99	-	1	1	1	-
1.0 - 1.49	-	1	1	2	1
1.50 - 1.99	-	3	2	-	-
2.00 - 2.49	-	1	4	4	1
2.50 - 2.99	-	-	-	-	-
3.00 - 3.99	-	2	1	2	-
4.00 - 4.99	-	2	3	2	2
Over 5.00	-	4	6	-	1
No Answer	19	124	122	90	56

TABLE A. 22                    NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON FRESH WATER FISH-INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	1	6	-	-	2
0.5 - 0.74	-	1	-	-	1
0.75 - 0.99	-	1	-	-	-
1.0 - 1.49	-	1	-	-	2
1.50 - 1.99	-	-	-	1	-
2.00 - 2.49	-	-	-	-	-
2.50 - 2.99	-	-	-	-	-
3.00 - 3.99	-	-	-	-	-
4.00 - 4.99	-	1	1	-	-
Over 5.00	1	1	-	-	-
No Answer	2	39	20	19	20

TABLE A.23                    NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON CRABS - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	14	49	16	19	8
0.25 - 0.49	13	53	19	14	10
0.50 - 0.99	5	27	16	22	12
1.0 - 1.49	1	10	6	10	6
1.5 - 1.99	1	8	5	8	4
2.0 - 2.49	4	14	5	3	3
2.5 - 3.49	1	17	9	5	6
3.5 - 4.99	1	4	3	7	9
5.0 - 7.99	3	6	6	9	12
Over 7.5	1	5	4	8	8
No Answer	189	288	5	86	36

TABLE A.24                    NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON CRABS - CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	1	11	5	5	4
0.25 - 0.49	-	10	6	2	6
0.50 - 0.99	2	10	14	9	10
1.0 - 1.49	-	2	4	6	3
1.5 - 1.99	-	2	4	4	1
2.0 - 2.49	-	3	4	4	1
2.5 - 3.49	-	4	6	3	1

Table A.24 (Cont.)

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
3.5 - 4.99	1	3	4	3	4
5.0 - 7.99	-	2	5	5	5
Over 7.5	-	2	10	3	8
No Answer	15	108	93	66	23

TABLE A.25                      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON CRABS - INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	2	2	-	-	1
0.25 - 0.49	-	6	1	-	-
0.50 - 0.99	1	6	-	5	2
1.0 - 1.49	-	6	1	1	1
1.5 - 1.99	-	1	2	1	3
2.0 - 2.49	-	7	2	-	1
2.5 - 3.49	-	3	-	4	1
3.5 - 4.99	-	2	2	-	1
5.0 - 7.49	-	2	3	-	1
Over 7.5	-	-	2	1	6
No Answer	1	15	8	9	8

TABLE A.26                      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON FRESH PRAWNS - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	47	81	20	26	11
0.5 - 0.99	18	51	18	17	6
1.0 - 1.49	13	37	13	7	2
1.50 - 1.99	8	34	8	4	6
2.0 - 2.99	22	60	34	23	6
3.0 - 3.99	7	21	12	15	3
4.0 - 5.99	4	40	24	14	14
6.0 - 7.99	5	25	7	21	12
8.0 - 9.99	3	16	12	13	7
Over 10.00	6	29	26	37	20
No Answer	100	87	20	14	7

TABLE A.27      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON FRESH PRAWNS - CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	4	22	26	8	5
0.5 - 0.99	2	13	9	4	3
1.0 - 1.49	2	12	13	10	1
1.50 - 1.99	2	4	3	3	1
2.0 - 2.99	1	17	12	9	6
3.0 - 3.99	1	3	5	5	7
4.0 - 5.99	-	19	19	18	6
6.0 - 7.99	-	8	9	7	4
8.0 - 9.99	-	10	15	16	5
Over 10.00	1	16	25	20	24
No Answer	6	33	19	10	4

TABLE A.28      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON FRESH PRAWNS - INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	-	6	1	-	-
0.5 - 0.99	1	4	3	2	-
1.0 - 1.49	-	2	-	1	-
1.50 - 1.99	-	5	-	-	2
2.0 - 2.99	1	2	2	3	-
3.0 - 3.99	-	3	2	3	2
4.0 - 5.99	1	4	4	4	3
6.0 - 7.99	-	6	-	2	3
8.0 - 9.99	-	1	2	3	2
Over 10.00	1	7	1	1	8
No Answer	-	10	6	1	5

TABLE A.29      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON DRIED PRAWNS - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	41	85	27	18	10
0.5 - 0.99	8	23	8	8	7
1.0 - 1.49	21	49	13	18	7
1.50 - 1.99	16	51	25	26	8
2.0 - 2.99	9	40	22	24	11
3.0 - 3.99	6	30	16	26	14
4.0 - 5.99	-	5	3	5	7
6.0 - 7.99	-	13	4	10	11
8.0 - 9.99	1	4	2	3	4
Over 10.00	2	9	5	15	13
No Answer	129	172	69	38	22

TABLE A.30      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON DRIED PRAWNS - CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	16	46	33	20	11
0.5 - 0.99	2	7	10	7	5
1.0 - 1.49	-	14	16	11	5
1.50 - 1.99	-	7	9	11	5
2.0 - 2.99	-	7	13	10	6
3.0 - 3.99	-	4	9	8	8
4.0 - 5.99	-	-	1	1	1
6.0 - 7.99	-	1	4	4	1
8.0 - 9.99	1	2	3	1	2
Over 10.00	-	5	3	3	-
No Answer	10	64	54	34	22

TABLE A.31      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON DRIED PRAWNS - INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.49	1	3	3	-	1
0.5 - 0.74	-	3	-	-	-
0.75 - 0.99	1	7	1	3	-
1.0 - 1.49	1	3	1	2	2
1.5 - 1.99	-	1	2	2	5
2.0 - 2.49	-	2	1	1	1
2.50 - 2.99	-	1	2	-	-
3.00 - 3.99	-	1	-	2	1
4.00 - 4.99	1	-	-	1	-
Over 5.00	-				
No Answer	-	28	11	8	15

TABLE A.32      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY  
EXPENDITURE PER HOUSEHOLD ON CUTTLEFISH - MALAYS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	33	70	10	17	5
0.25 - 0.49	18	57	15	16	11
0.50 - 0.99	17	46	18	22	13
1.0 - 1.49	8	32	10	16	5
1.5 - 1.99	2	20	7	14	7
2.0 - 2.49	13	29	28	12	8
2.5 - 3.49	8	33	14	16	14
3.5 - 4.99	5	25	14	12	14
5.0 - 7.49	8	10	11	17	6
Over 7.5	3	14	12	9	14
No Answer	118	145	55	40	17

TABLE A.33      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON CUTTLEFISH-CHINESE

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	2	20	17	9	6
0.25 - 0.49	2	3	-	3	3
0.50 - 0.99	1	15	16	5	5
1.0 - 1.49	1	9	14	11	6
1.5 - 1.99	-	2	6	4	3
2.0 - 2.49	-	9	12	11	6
2.5 - 3.49	-	2	6	7	2
3.5 - 4.99	1	4	15	7	9
5.0 - 7.49	-	2	4	1	2
Over 7.5	-	1	3	3	1
No Answer	12	90	62	49	23

TABLE A.34      NUMBER OF HOUSEHOLDS BY INCOME GROUP AND MONTHLY EXPENDITURE PER HOUSEHOLD ON CUTTLEFISH - INDIANS

<u>Expenditure</u>	<u>Less than \$100</u>	<u>\$100-199</u>	<u>\$200-299</u>	<u>\$300-499</u>	<u>\$500 and over</u>
0 - 0.24	1	2	-	-	1
0.25 - 0.49	1	1	1	-	1
0.50 - 0.99	-	3	3	3	2
1.0 - 1.49	-	1	-	1	2
1.5 - 1.99	-	-	-	1	1
2.0 - 2.49	-	4	3	2	2
2.5 - 3.49	-	1	3	1	2
3.5 - 4.99	-	1	3	-	1
5.0 - 7.49	-	2	-	1	1
Over 7.5	-	-	1	1	1
No Answer	2	35	7	10	11

