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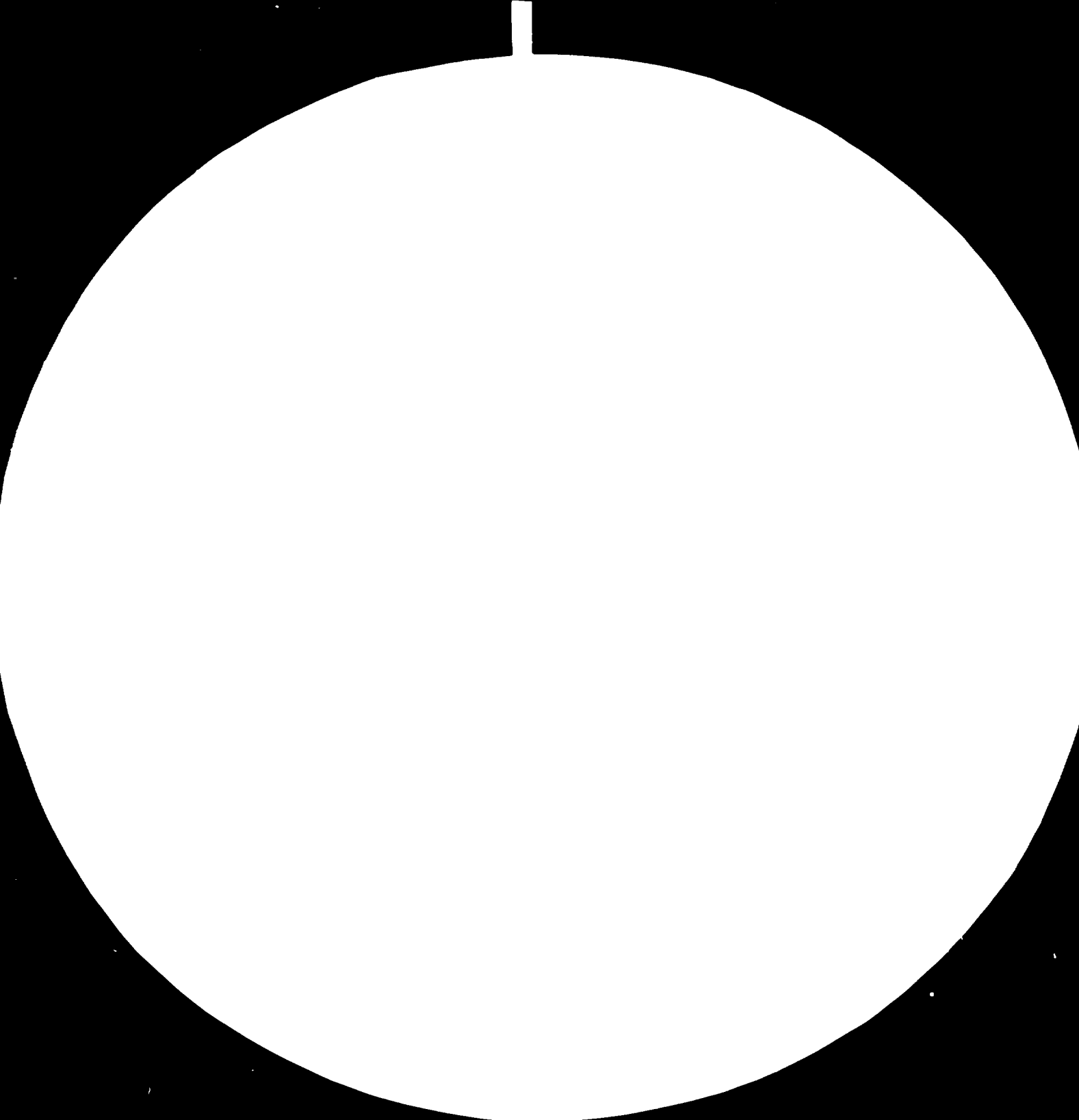

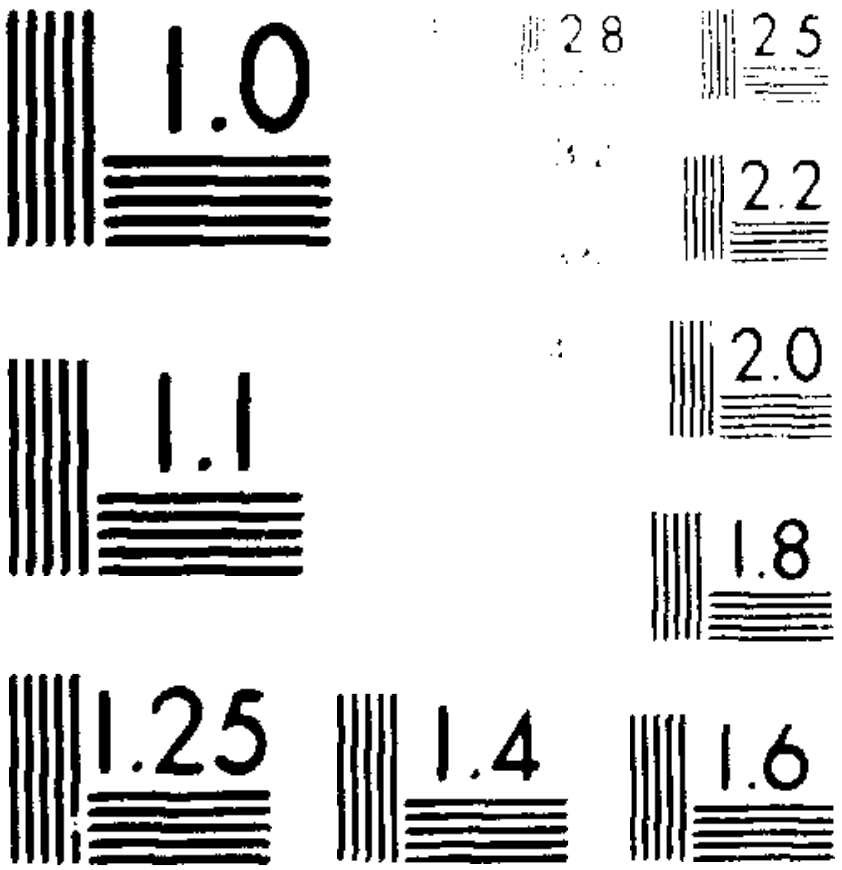
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17 October 1980
English

ASSISTANCE IN THE ESTABLISHMENT OF A FISH FEED MANUFACTURING PLANT

SI/VIE/79/802

VIET NAM

Terminal report

Prepared for the Government of Viet Nam
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Y. Nagai,
expert in fish feed manufacture

United Nations Industrial Development Organization
Vienna

80-44882

Explanatory notes

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Viet Nam is the dong (D). During the period covered by the report, the value of the D in relation to the United States dollar was US$ 1 = D 4.21.

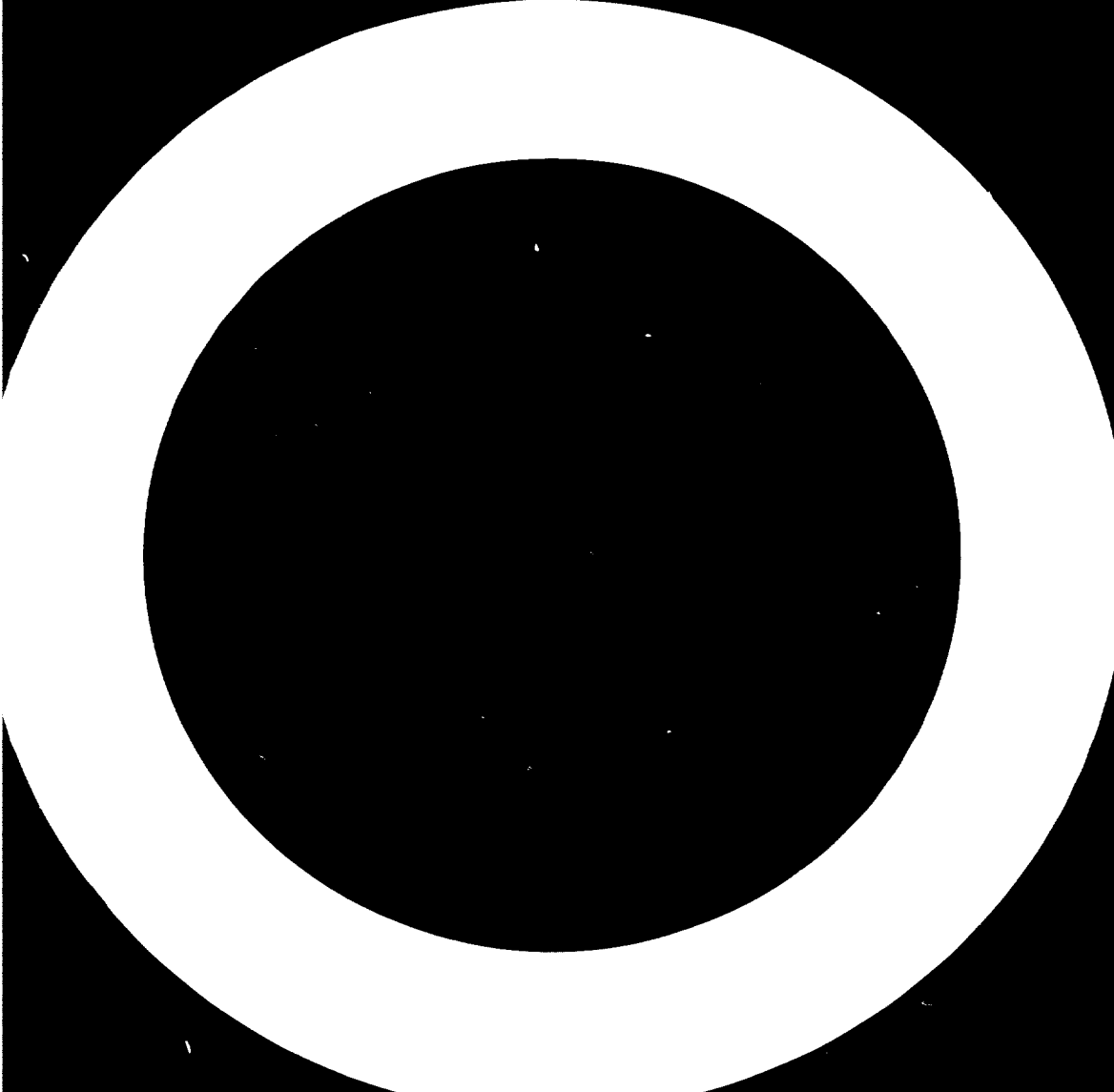
ABSTRACT

The project entitled "Assistance in the establishment of a fish feed manufacturing plant" (SI/VIE/79/802/B) arose from a request made in February 1979 by the Government of Viet Nam and approved in March 1979 by the United Nations Development Programme. The three-month mission took place in June-August 1980. The specific tasks of the expert included the following:

(a) Assessing present fish farming and feeding practices, types of feed used, availability of raw materials for the production of fish feed, and potential fish feed requirements;

(b) Determining the optimum composition of fish feed for different feeding purposes.

The main conclusion of the expert was that the project to establish an artificial fish feed mill at Ho Chi Minh City is feasible.



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INTRODUCTION

The purpose of this study is to determine whether it is feasible to establish an artificial fish feed mill at Ho Chi Minh city at a cost of $ 800,000.

The expert was informed before the mission that production of artificial fish feed is necessary in Viet Nam to support intensive fish culture on the Mekong River, especially cage culture. However, detailed information was not available outside Viet Nam. The intensive fish culture industry that existed in Viet Nam in the past has declined, and the financial resources needed to revive it are at present unavailable.

The demand for freshwater fish culture is very high in Viet Nam. The aim is to harvest more fish, and the most practical means of doing so is to develop the extensive fish culture existing under present economic conditions. Substantial supplies are available for fish culture and the government is ready to supply fingerlings to fish-farms. However, there is not enough feed to promote any type of fish culture. Extensive culture is the most suitable for producing more fish at the lowest cost. Unlike intensive fish culture, no equipment investment is needed for extensive fish culture, which could be rapidly developed with an artificial feed supply. Those concerned with fish culture in Viet Nam are therefore looking forward to the establishment of a fish feed mill.

The raw materials available for fish feed manufacture are very limited in Ho Chi Minh City. Vitamins, minerals and other artificial fish feed additives are scarce, and the production of high-protein feeds is not feasible under present conditions. The feed currently producible is to be used to supplement the natural fish productivity of the environmental waters. By that means, it is possible to produce five tonnes of fish per 0.4 ha of water surface annually using artificial feeds manufactured in Viet Nam.

A fish feed mill could be built with a proposed budget of $ 800,000 at Ho Chi Minh City. However, the efficient operation of the mill will require careful management of the raw materials.

To ensure the provision of dried raw materials throughout the year, a raw materials drying unit should be operated at the production site,

especially during the rainy season. It is hoped that an additional sum of approximately $ 200,000 might be added to the budget to meet the need for raw materials.

The establishment of a brackish water fish culture at Ho Chi Minh City would be unsuitable at present, but should be taken up in the near future.

I. FISH AND FEEDING

An outline of present fish culture in Ho Chi Minh City

General situation of freshwater fish culture in Viet Nam

The total annual fish catch in Viet Nam is at present about 180,000 t. The country needs more fish, but it is difficult to increase marine fish production quickly because of the shortage of fishing boats and fuel supplies. Fish culture would be a practical means of increasing fish production, especially freshwater fish culture in the southern region where natural conditions are favourable. The Government of Viet Nam wants to harvest 8,000 t of cultured freshwater fish in 1980 and to increase the yield to 20,000 t in 1985 through the promotion of artificial cultures. Local authorities in southern Viet Nam have begun to take action to increase freshwater fish culture.

General plan and action taken by Ho Chi Minh City

General plan

There are 2,400 ha of freshwater fish culture ponds in Ho Chi Minh City. However, only 400 ha of those ponds are actually producing fish. At present, the annual production of freshwater fish cultures is approximately 5,000 t in Ho Chi Minh City, and the Government wishes to increase production to 10,000 t in 1985. To achieve that goal, the supply of fingerlings and feeds to fish farms must be increased. The following measures were therefore taken by the Government to meet those needs.

Foundation of a fish culture centre

A fish culture centre was founded at Binh Phu in 1978. The centre has 7 ha of water surface with hatcheries, nurseries and a laboratory. One of the main tasks of the centre is to supply fingerlings to fish farms. During the past year, it produced 2,000,000 fingerlings by artificial propagation and distributed them among fish farms. The fingerlings of grass carp and silver carp are obtainable only in Ho Chi Minh City, and thirty two persons are engaged in fish keeping, fry production, and the nursing and selling of fingerlings.

Establishment of a pilot fish farm

A pilot fish farm was established at Song Ten in 1978. At present, fish is being produced by polyculture under 4 ha of water surface. Seventeen persons are employed at the farm, which is being expanded to provide 54 ha of water surface. An annual fish yield of 300 t is expected when construction is completed.

Promotion of fish culture in People's co-operatives

Ho Chi Minh City has fifteen people's co-operatives where piggery, vegetable culture and fish farming are combined. Each co-operative has a fish culture pond with an average size of about 7 ha. More people's co-operatives will be organized in the near future under government supervision.

Ao Ca Bac Ho movement

A national movement called Ao Ca Bac Ho, which means "let us culture fish according to late President Ho Chi Minh's will", has recently arisen. All those who wish to culture fish are included in the movement, which can help to increase fish production if the Government supplies more fingerlings and feeds.

Supports expected

There are fifty five small fish culturists in Ho Chi Minh City. They can help the Government in fry production of tilapia and common carp.

The neighbouring province of Ho Chi Minh City, Son Be, also established a big fish culture centre at Thuan An in 1979. The centre, has a hatchery with an annual capacity of 5,000,000 fingerlings, which could help to meet the needs of Ho Chi Minh City.

When more grass carp and silver carp parent fish are needed in Ho Chi Minh City, the Government can assist by supplying parent fish by air from the north of the country.

Present technological characteristics of freshwater fish culture in Ho Chi Minh City

Conventional fish farming methods

Although traditional pet fish culture has a long history, edible fish culture is a new industry in Ho Chi Minh City. Catfish culture

arose about twenty years ago in the Mekong River area and tilapia culture was imported in 1974. During the last three years grass carp and silver carp culture were introduced from the north of the country. A conventional fish culture method involves polyculture without artificial feeding or polyculture under water fertilization. A general feature of the conventional method is an extensive mixed culture of several fishes in various combinations, without particular feeding requirements.

Yield of fish culture without artificial feeding

Fish yield varies depending on the amount of available natural feeds in water. Generally, it lies between 0.6 t and 1 t per ha per annum and does not exceed 1 t.

Yield of fish culture by water fertilization

Animal manures, such as pig dung, are commonly used as water fertilizers. Inorganic fertilizers are avoided, except for lime, which is used as a disinfectant and a neutralizer. The Binh Phu fish culture centre has recently demonstrated that 4-5 t of fish per ha per annum can be harvested by applying pig dung in a still water pond for polyculture. It seems that such a yield can be achieved even by conventional methods, if sufficient organic fertilizers are available.

Pond structure

The fish ponds vary in size from 1 to 7 ha. They are dug in the ground with a water depth of 0.4-1 m and grass growing around. No aeration is carried out. Generally, the water source is rain or river water, which is turbid in the rainy season, when the fish are therefore not observable directly by human eyes. Usually, the bottom of the pond is muddy.

Intensive fish culture

About 100 cage ships are working at Chau Doc river rearing catfish with boiled trash fish being used as feed. Several other cage ships are also operating in rivers. However, government assistance is not provided for such intensive fish culture. The government concern is to consolidate extensive fish culture quickly and to obtain more fish at less cost. Intensive fish culture is practiced by fish culturists, but at present its financial prospects remain uncertain.

Brackish water fish culture

Brackish water fish culture has not yet started. The Government is planning to establish an artificial culture of Giant River Prawn (Macrobrechium rosenbergii), which is expected to be a profitable export commodity. An artificial hatchery of that prawn will soon be reopened and an artificial culture pilot farm will be established in the near future at Ho Chi Minh City.

Fish production plan of Ho Chi Minh City

Programme for the annual production of 10,000 t of fish

In the south of Viet Nam, environmental water has a natural fish productivity of 1 t per ha per annum. The application of water fertilizers such as animal manures increases that productivity several times. Assuming that a feed conversion rate is 0.8 and 5t of artificial feed are supplied to 1 ha of water surface with enough fingerlings, 4 t of fish per year may be harvested. Adding 1 t of fish to be reared by natural feed, 5 t of annual fish yield per ha can be expected per 5 t of artificial feed used. More than 2,000 ha of water surface are suitable for fish culture in Ho Chi Minh City. It is therefore theoretically possible to produce 10,000 t of fish using 10,000 t of artificial feed if a fish feed mill of the above-mentioned production capacity is established.

Target fish species

The following five species of fish have been selected for production.

1.	Tilapia	Tilapia nilotica
2.	River catfish	Pangasius micronemas
3.	Common carp	Cyprinus carpio
4.	Grass carp	Ctenopharingoden idellus
5.	Silver carp	Hypophthalnictis meritrix

The necessary fingerlings are available and the Government distributes the products. The fish is reared under polyculture. A suitable combination of annual production targets for each fish is as follows:

Fish	Production (t)
Tilapia	4,000
River catfish	3,000
Common carp	1,000
Grass carp	1,000
Silver carp	1,000

Supply of fingerlings

The technical procedure for the artificial propagation of grass carp and silver carp has been established in the Binh Phu fish culture centre. The centre can supply annually about 2,000,000 of their fingerlings. The necessary frys and fingerlings of tilapia and common carp can be supplied by private fish culturists, who can produce about 5,000,000. Fish farmers can also supply a certain amount of tilapia fingerlings. River catfish frys are abundant in the Mekong River, where professional collectors can catch 30,000,000 frys in a season. After a short nursing period, they sell the fingerlings. Assuming that one fingerling grows to 1 kg in a year, sufficient quantities of fingerlings can be produced and supplied. A somewhat larger amount of fingerlings are of course needed to supplement any loss that might occur during culture.

Supply of artificial feeds

Ten thousand tonnes of artificial feed are needed to harvest 10,000 t of fish per year, as calculated above. Without a feed mill of that production capacity, it would be difficult to carry out the fish production plan of Ho Chi Minh City. The artificial fish feed production plan will be described later.

Raw materials for artificial feed

Principles of raw material selection

The following principles should be kept in mind in the selection of the necessary raw materials for fish feed manufacture:

(a) The raw materials should all be produced domestically;
(b) Feeding materials should not be used to the detriment of foodstuffs for human consumption;
(c) The use of vitamins, minerals and other additives should be avoided;
(d) Wet raw materials should be dried;
(e) The seasonal variation in raw material supply is unavoidable.

Available raw materials

The available raw materials are presented in table 1.

Table 1. Available raw materials

Materials	Annual amount (t)	Special conditions
Trash fish	10,000	Wet
Shrimp hull	1,000	Air-dried, September-December
Rice bran	3,000	Air-dried, throughout the year
Tapioca meal	10,000	Wet, obtainable air-dried
Fermentation by-products	10,000	Wet, throughout the year
Peanut meal	300	Air-dried, throughout the year
Coconut meal	600	Air-dried, throughout the year

The following points should be noted in connection with table 1:

(a) Non-edible small fish for feed use is produced at several distinct places, including: 1,000 t on the east coast, 3,000 t at Ho Chi Minh City, 3,000 t at Hong Ngu (Mekong River side) and 3,000 t at different seaside locations.

An artificial drying device is needed at the production site, especially for the rainy season;

(b) Shrimp and prawn hulls may be collected from the processing and freezing factories. Some amount of fish heads and internal organs are also available from those factories, but not on a regular basis;

(c) Tapioca meal is used as a binding material of pellet formation;

(d) Annually, 2,400 t of fruit peelings of various sorts may be used depending on their quality which fluctuates considerably;

(e) The only animal by-product left for fish feed use is pig stomach organs from the slaughterhouse, which can be substituted for fermentation by-products.

Drying of raw materials

All the raw materials should be dried before being stored in a raw material tank in the feed mill. The desirable moisture content is under 12 per cent. It is also desirable to complete the drying process at the raw materials production site.

Artificial feed production plan

Types, textures and sizes

Four types of artificial feeds are necessary to produce the desired amounts of fish. They are mash, crumble, pellet and expanded pellet, which are used as follows:

(a) Mash is for fingerlings of all kinds and for silver carp through all its growing stages;
(b) Crumble is for all larger fingerlings;
(c) Pellet is for bottom feeding fishes.

Because silver carp is characterized by plankton feeding, mash feed is recommended for all its growth phases. Expanded pellet is suitable for feeding tilapia, grass carp and the other surface feeders. After training, those fish also become accustomed to eating ordinary pellet. Expanded pellet is manufactured by means of an extruder-expander machine to give the product a porous texture. The product holds many small air bubbles through expansion and can float on the water surface until the air bubbles are filled with water.

Mash and crumbles have the same raw material composition. They differ only in texture and size. The size of the feed should be decided according to the desired size of the fish. Mash is a mixture of raw materials which are powdered to less than 1 mm and used to feed frys with a body weight below 10 g. Crumbles are feeds of 1-2 mm and 2-3 mm. They are used to feed fingerlings with a body weight of, respectively 10-50 g and 50-100 g.

The two kinds of cylinder-shaped pellet are 4 mm and 6 mm in diameter, and respectively 7 mm and 10 mm in length. The characteristics of the feed are summarized in table 2. The expanded pellets have a spherical shape.

Table 2. Type, texture and size of feeds

Type of fish	Fish size (g)	Type and texture of feed	Size (mm)
Frys	10	Mash	1
Fingerlings	10- 50	Crumble	1-2
Fingerlings	50- 100	Crumble	2-3
Tilapia	100- 500	Expanded pellet	4
Tilapia	500-1000	Expanded pellet	6
River catfish	100- 500	Pellet	4
River catfish	500-1000	Pellet	6
Common carp	100- 500	Pellet	4
Common carp	500-1000	Pellet	6
Grass carp	100- 500	Expanded pellet	4
Grass carp	500-1000	Expanded pellet	6
Silver carp	All sizes	Mash	1

Feed formulas

The following provisional formulas are arranged for each type of fish, considering its feeding habits and the total amount of available raw materials. When raw materials of better quality become available, the formulas which are broken down in table 3 will be improved.

Table 3. Composition of artificial feeds (percentage)

Ingredients	Frys and fingerlings	Tilapia	River catfish	Common carp	Grass and silver carp
Fish meal	35.0	20.0	30.0	25.0	10.0
Tapioca meal	25.0	25.0	25.0	25.0	30.0
Rice bran	17.0	30.0	15.0	25.0	40.0
Peanut meal	15.0	-	5.0	-	-
Coconut meal	10.0	3.0	5.0	5.0	-
Yeast	3.0	-	-	-	-
Shrimp hull	-	5.0	20.0	10.0	10.0
Fermentation By-Products	-	17.0	-	10.0	10.0

Artificial feeds of the above composition should be used to feed fish in green water and to supplement vitamins and minerals provided by natural feeds. They are practical rather than complete feeds.

Rice bran is replaceable by wheat bran, and fermentation by-products, etc. are replaceable by pig stomach contents or fish sauce (Nuoc mam) residue meal. The moisture content of the product should be kept below 12 per cent.

The crude protein level of each feed is calculated as shown in table 4.

Table 4. Crude protein level of feed

Type of fish	Protein level of feeds (%)
Frys and fingerlings	29.2
Tilapia	20.3
River catfish	24.0
Common carp	24.1
Grass and silver carp	16.3

The following crude protein contents were used to calculate the protein level of feeds: fish meal, 60 %; rice bran, 13%; peanut meal, 40 %; coconut meal, 15 %; shrimp hull, 35 %; fermentation by-products, 10 %; and tapioca meal, 2 %.

Annual production scale

The required annual feed production is calculated as shown in table 5.

Table 5. Annual feed production plan

Type of fish	Mash (t)	Crumbles (t) 1-2 mm	Crumbles (t) 2-3 mm	Pellets (t) 4 mm	Pellets (t) 5 mm	Total (t)
Tilapia	40	160	250	(1600)	(2000)	4000
River catfish	30	120	150	1200	1500	3000
Common carp	10	40	50	400	500	1000
Grass carp	10	40	50	(400)	(500)	1000
Silver carp	1000	-	-	-	-	1000
	1090	360	450	3600	4500	10000

The artificial feeds for grass and silver carp have the same composition but are different in kind. The production plan for expanded pellets is shown in parenthesis.

Required raw materials

The amount of raw materials required to manufacture 10,000 t of artificial feeds is shown in table 6.

Table 6. Required raw materials

(tonnes)

Ingredients	Frys and fingerlings	Tilapia	River catfish	Common carp	Grass and silver carp	Total
Fish meal	350	720	810	225	180	2285
Tapioca meal	250	900	675	225	540	2590
Rice bran	170	1080	405	225	720	2600
Peanut meal	100	-	135	-	-	235
Coconut meal	100	108	135	45	180	563
Shrimp hull	-	180	540	90	180	990
Yeast	30	-	-	-	-	30
Fermentation by-Products	-	612	-	90	-	702
Total	1000	3600	2700	900	1800	10000

At present more ingredients are required because various losses occur during manufacture. Pelleting and expansion losses may be 3 and 10 per cent respectively. Crumbling loss may be about 30 per cent. A loss might also take place as a reult of overdrying the products.

Feeding experiments

Feed preparation test

Test feeds for tilapia, river catfish, grass carp and frys were prepared by hand on the basis of the formulas described above. The raw materials were dried and pulverized before the use. Each kilogram of the feed mixture was formed into a dough with an addition of water, then separated into several dumplings and steamed in a small kitchen steamer for 25 minutes to obtain firmly heat-coagulated dumplings. The dumplings thus prepared were extended on a chopping board by hand, cut into small pieces by knife, then air-dried. The pellets were ground by passing them through a hand coffee mill, then sieved to separate crumbles from a finely powdered fraction. It was ascertained that the formulas described were suitable for preparing pellets and crumbles. All the crushed fractions were combined for use in the feeding experiments described below.

Feeding experiments

Four fish cages were installed by means of nets in a fish culture pond of good natural productivity at the Binh Phu fish culture centre. Each fish cage, measuring 1 m x 1 m x 1 m, housed 1kg of the fingerlings of tilapia, river catfish and grass and silver carp. Fingerling size was varied from 5 g to 10 g. Each morning for 10 days, 30 g of the artificial feed was given to the caged fish. On the morning of the eleventh day, fish were weighed to check their growth. The results are shown in table 7.

Table 7. Results of feeding experiment

Feed Effect	Tilapia	River catfish	Grass carp	Silver carp
A. Initial body weight	1.0 kg	1.0 kg	1.0 kg	1.0 kg
B. Final body weight	1.42 kg	1.70 kg	1.16 kg	2.20 kg
C. Feeds given	300 g	300 g	300 g	300 g
Feed efficiency	1.40	2.33	0.53	-

Note: Feed efficiency is expressed as (B-A)/C.
For silver carp, the artificial feed intake was not observed during the feeding experiment.

When the feeding experiment was completed, the contents of the digestive tracts of the fish were examined under a microscope. Except for silver carp, the ingestion of the artificial feed was confirmed in each species of fish examined. However, much intake of natural feed was also observed in every fish.

Tilapia, river catfish and grass carp became accustomed to absorbing the artificial feeds quickly, but silver carp did not. More examination is necessary to determine what sort of artificial feed is most suitable for fish growth under such natural conditions.

Expected profit of fish culture

Assuming that 1 ha of water surface produces 5 t of fish annually and that two persons take care of the 1 ha of water surface, the annual income and expense per capita were calculated as in table 8.

Table 8. Per capita annual income from fish culture

Items	Tilapia	River catfish	Common carp	Grass carp	Silver carp
(a) Fish production (kg)	2500	2500	2500	2500	2500
(b) Unit fish price (D/kg)	3.5	4.0	4.0	4.0	4.0
(c) Gross sales (D)	8750	10000	10000	10000	10000
(d) Fingerlings needed (heads)	2500	2500	2500	2500	2500
(e) Unit price (D/head)	0.1	0.5	0.3	0.4	0.4
(f) Fingerlings cost (D)	250	1250	750	1000	1000
(g) Artificial feed needed (kg)	2500	2500	2500	2500	2500
(h) Unit feed price (D/kg)	2.0	2.0	2.0	2.0	2.0
(i) Feed cost (D)	5000	5000	5000	5000	5000
(j) Management expenses (D)	1000	1000	1000	1000	1000
(k) Miscellaneous expense (D)	500	500	500	500	500
(l) Income (D) (c-h-i-j-k)	2000	2250	2750	2500	2500

Note: D (Dong) represents the unit of currency in Viet Nam. Approximately, 4.21 Dongs are equivalent to $ US 1.0.

The income calculated per capita differs depending on the type of fish reared. The actual income will vary more depending on the polyculture selected and the skill of the fish culturist. In general, the income and expense balance of fish culture as described above is reflected in table 9.

The Government hopes to establish a final artificial feed price of less than 2 D/kg. The current unit price of raw materials is shown in table 10. The raw material prices given are government prices applied in Ho Chi Minh City.

Table 9. Income and expense balance of fish culture

Item	Balance (%)
Gross income	100
Costs	
Fingerlings	10
Feed	50
Management	10
Miscellaneous	5
Gross profit	25

Table 10. Current price of raw materials

Raw materials	Price (D/kg)
Dried trash fish	1.5
Tapioca meal	1.0
Rice bran	1.0
Shrimp hull	0.5
Peanut meal	2.0
Coconut meal	1.5

II. FISH FEED MILL

Government objectives

If possible, the Government hopes that the following goals can be achieved in Ho Chi Minh City by means of international co-operation, especially within the United Nations system:

(a) The establishment of an artificial fish feed mill with an annual production capacity of 10,000 t and the following equipment and infrastructure:

1. One ha of ground
2. A truck road 2 km long and 6 m wide for transporting materials and products from the plant to the national highway
3. An electric substation at the plant to convert 1,500 V to 380 V, 220 V and 110 V, 50 cycles
4. Water facilities
5. A 15-horse power electric boiler for steam supply
6. An extruder-expander pellet machine and an ordinary pellet machine
7. A general office building, a warehouse and a raw material storehouse with a small refrigeration room
8. A raw material drying plant annexed to the plant
9. A bus for labour transport (40 persons)

(b) The setting-up of a trash fish drying branch at Hong Ngu on the Mekong River side, which is 230 km from Ho Chi Minh City, with the following facilities:

1. A drier with a daily capacity of 20 t and powered by heavy oil
2. A covering house for the drier
3. A light truck with a carrying capacity of 2 t
4. Two diesel trucks with a carrying capacity of 7 t
5. Two sets of 300 hp boat engines and two sets of 250 hp boat engines with shafts and propellers respectively.

(c) The acquisition of two transportable small driers with a daily capacity 5ft and powered by heavy oil. The driers would be used at different trash fish production sites during the fishing seasons.

Location

The fish feed mill construction site has already been selected by the Ho Chi Minh City authorities.

Fish feed mill construction site

A site for the construction of the fish feed mill has been selected between two hills at Long Binh, about 20 km from the centre of the city and 2 km from the national highway No. 1. Earthwork is necessary to flatten the ground, which is firm with a rocky subsoil. There is a small river nearby measuring 4 m and 2 m in depth. The river has never flooded and there are few houses around.

Electrical facilities

A high-tension electric wire of 1,500 V is running alongside national highway No. 1. To build an electric substation at the mill, the following separate voltages are requested: 380 V for electric boiler and drier, 220 V for motors, and 110 V for ordinary electric tools.

Road condition

The existing road connecting the selected fish feed mill construction site and the highway is narrow and rough. Improvements are necessary.

Water facilities

Underground water is abundant but slightly turbid. A well may supply enough water all year around. Daily needs would be 40 - 50 t, and precipitation or filtration of water may be needed.

A future plan

Ho Chi Minh City has a plan to establish a giant river prawn culture station near the factory. The plant is also expected to produce artificial feed for the prawn.

General production specifications

Outlines of artificial fish feed production

The plant has a daily production capacity of about 30 t of artificial fish feed in on eight-hour shift. It is operated by electricity as the sole energy source. About 60 persons are needed for full operation. Based on five different basic feed formulas, twelve different types of fish feed of four different textures, i.e. mash, crumble, pellet and expanded pellet, are manufactured.

Feed sizes are adjusted according to the desired fish species and their growing stages. Among the main ingredients, dried fish, tapioca meal, rice bran and shrimp hull are kept in raw material tanks, but sub-ingredients are stored in bags. After processing, the products are sealed in 10 kg or 20 kg plastic packing bags covered by kraft papers. In future, bulk transport may be considered. For the present, transport is done wholly by lorry. The extruder-expander machine that may be introduced has insufficient capacity to produce the requested amount of expanded pellet in one shift. Overtime work should be considered occasionally.

Process flowsheet

The process flow is illustrated in figure I. The main ingredients are received in a hopper (HP1) and then sent to raw material tanks (TK1, TK2, TK3, TK4) by a bucket elevator (BE1) through a flow conveyor (FC1) and a distributor (DS). On the way, iron contaminents are removed by a magnet separator (MS). All the tanks are hopper tanks and cut gates and slide dumpers are set. After being weighed on a hopper scale (HS), rough ingredients are sent to a hammer mill (HM) by a screw feeder (SF1), but fine ingredients bypass the hammer mill riding on another screw feeder (SF2). Minor ingredients kept as fine powder are introduced by hand through a second hopper (HP2) set next to the hammer mill. All the powdery ingredients are sent to the upper floor by means of a bucket elevator (BE2) and arrive in a horizontal batch mixer (MX). After mixing, the feed mixtures go to service tanks (ST1, ST2, ST3) and are kept there for pelletization. As a mash feed, the mixture is directly usable and the mash feed is sent directly from

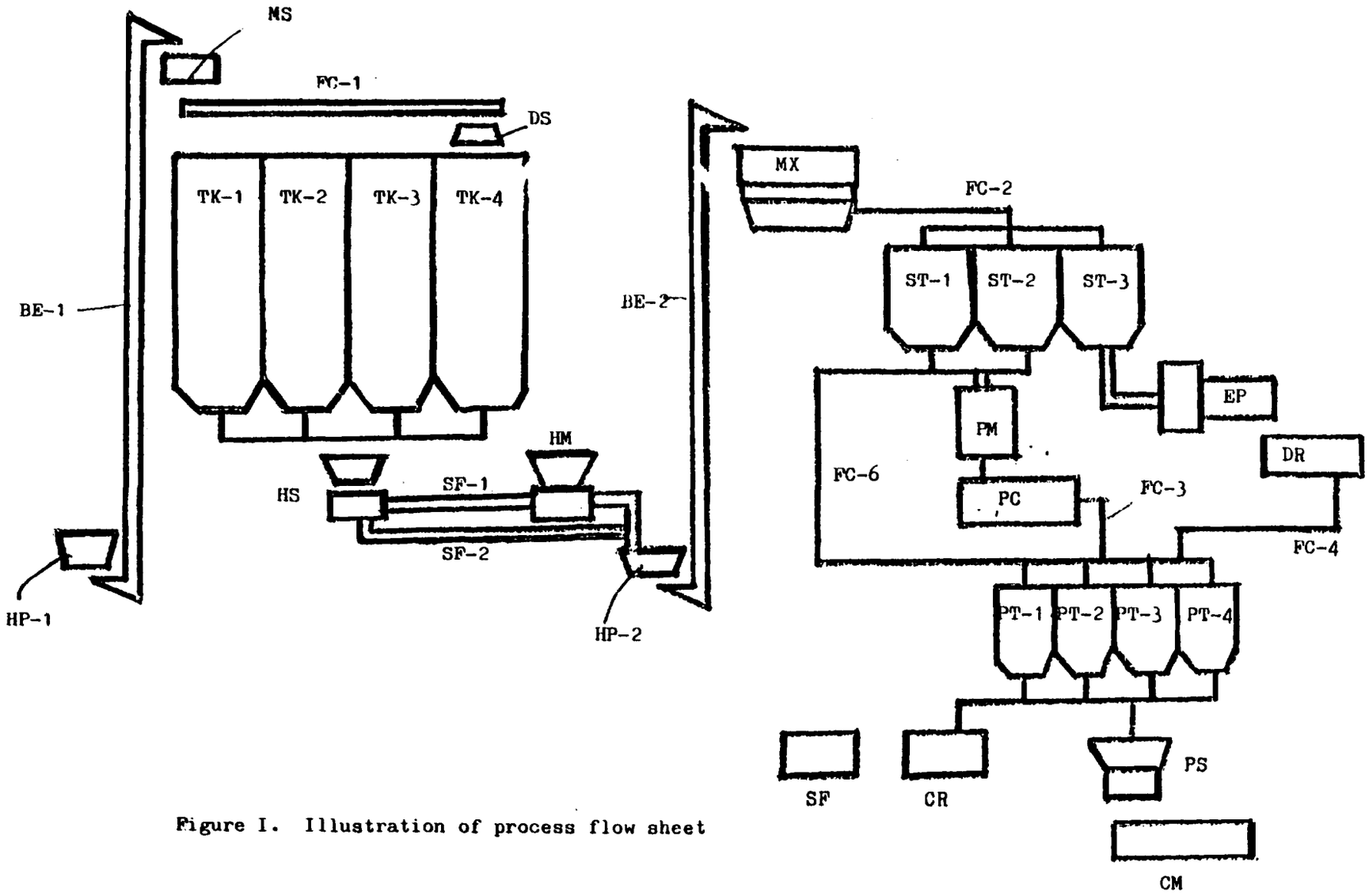


Figure I. Illustration of process flow sheet

service tank to a product tank and then to a packing line. A pellet mill (PM) receives the feed mixture from the service tanks by means of a screw feeder (SF3). The pellets formed are dried and cooled by a pellet cooler (PC) and sent to the product tanks (PT1, PT2, PT3, PT4). An extruder-expander machine does batch work after receiving mashed feed from a service tank through a screw feeder (SF4). The expanded pellets formed are dehydrated in a drier (DR) then sent to the product tank. The next processes are carried out at the ground floor again. A crumbler (CR) receives pellets for crumbling from a product tank by a flow conveyor (FC5), and the crumbles formed are sieved for fractionation by a sifter (SF) and then packed.

The larger fragments remaining uncrumbled are again returned by hand into the crumbler. Pellets and expanded pellets are weighed in bags on a packing scale (PS) and then the bags are sealed with strings by the closing machine (CM).

Layout

General plan

The general plan of the plant is illustrated in figure II. The plant consists of a main factory building (16 m x 24 m) with an annexed warehouse (8 m x 8 m) and another annexed drier house (12 m x 7 m). A general office (8 m x 10 m) and a raw material storehouse (8 m x 8 m) with a small cold room are built separately as shown in the illustration. An electrical substation is set outside the main building without covering. The main building contains three rooms on the ground floor, namely an electrical boiler room (4 m x 10 m), a locker room (4 m x 6 m) and a packing material storing room (2 m x 4 m). The main building is a two-story house with all the necessary equipment for processing the ground floor and upper floor, which are connected by two stairs at the corner. Open spaces on the ground floor are used to stock minor raw materials in sacks or bags for short periods of time. Generally speaking, feed materials are mixed and pelleted on the second floor of the main building and the products are packed on the ground floor. Related feed-manufacturing processes, such as hammer milling, crumbling, sifting and packing, are carried out on the ground floor. A cyclone dust collector

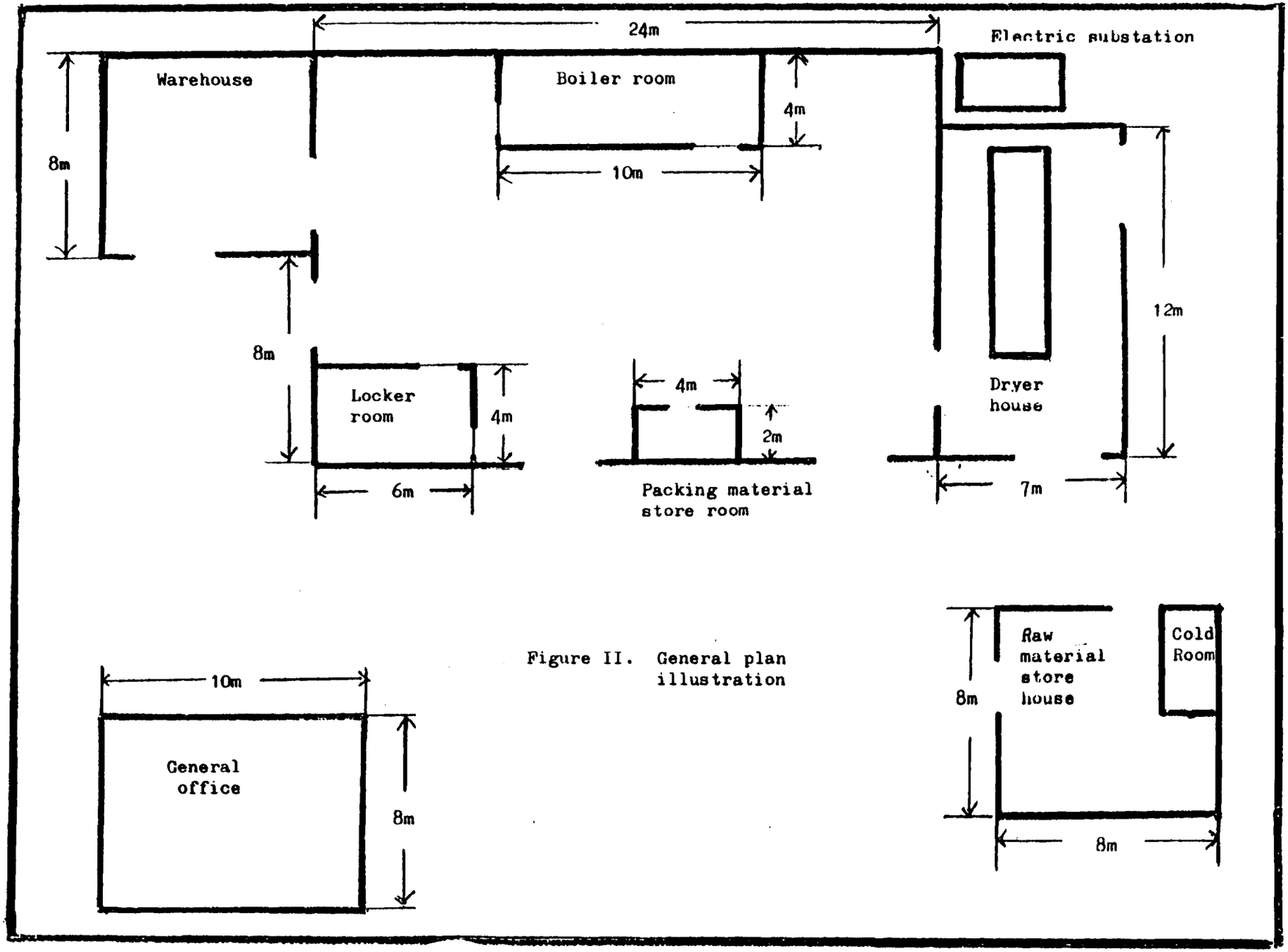


Figure II. General plan illustration

is needed to set over the hammer mill. The main building may have twenty fans to expell fine dusts and to introduce fresh air.

Plant layout

The plant layout is illustrated in figure III. All tanks and equipment are connected with feeders and dischargers. For upward transport in the plant, bucket elevators are used at two places, and for horizontal transport, flow conveyors are used freely. The screw conveyors are adapted to feed machines such as the hammer mill, pellet mill and expander machine. In general, the materials flow in batches and the operation is controlled manually. An automatic control system is not used.

Elevation

The elevation of the main building is illustrated in figure IV. The height of the second floor is 5.5 m and the maximum elevation of the building is 14 m where a bucket elevator carries up raw materials into the tanks.

Equipment specifications

High-pressure electrical boiler (100-125 psi)

The steam (120° C) consumption for pellet production is 5-6 % of raw material weight. For expanded pellet production, 15-16% of the raw material weight should be added as steam to a feed mixture. Therefore, the boiler should have a capacity of about 1 t of high-pressure steam for eight hours of operation. The boiler horsepower is expected to be more than 15 hp.

Tanks

Every tank is hopper-shaped at the bottom, with a manual gate system for material discharge. Flow conveyors are used for feeding the tank. The corner should be rounded inside the tanks to avoid discharge problems. Removable top coverings are needed. Four raw material tanks (each with a capacity of 25 t and measuring 3 m x 3 m x 7 m), three service tanks (each with a capacity of 12 t and measuring 2 m x 3 m x 5 m) and four product tanks (each with a capacity of 8 t and measuring 2 m x 2 m x 5 m) are needed. Two-way dampers should be

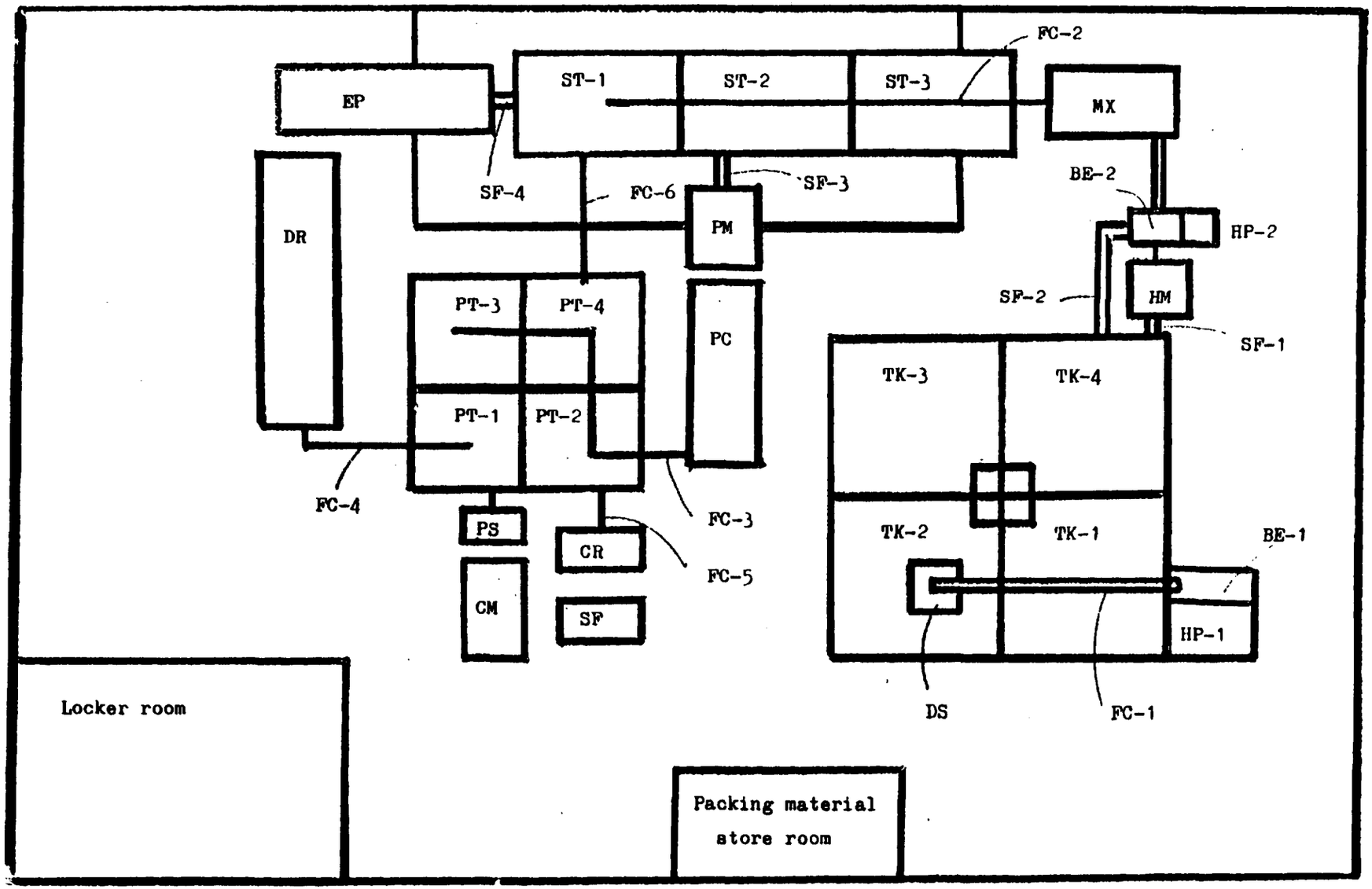


Figure III. Layout illustration

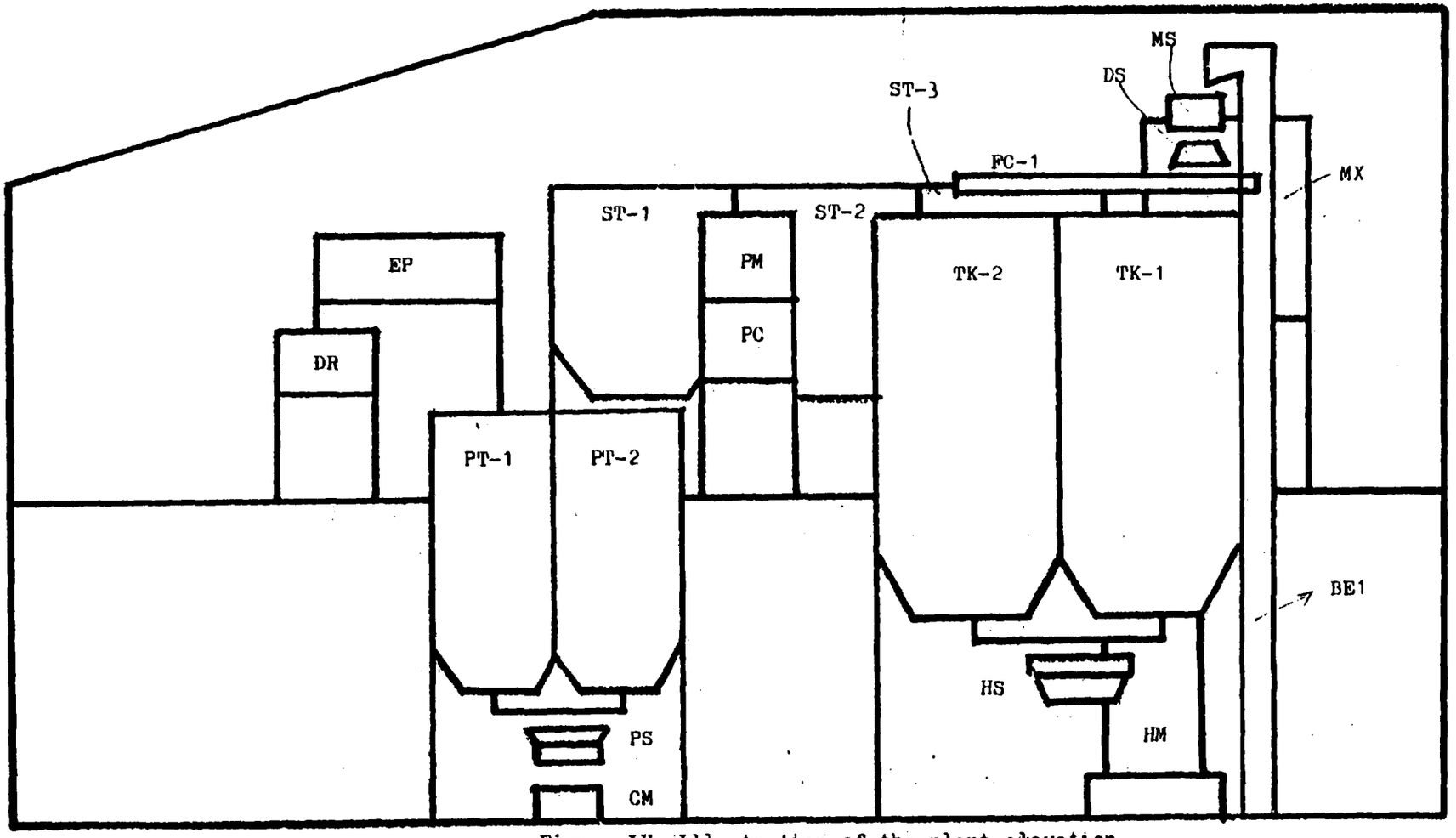


Figure IV. Illustration of the plant elevation

set to the discharge flow system of each tank group, except for the raw material tanks. To reduce costs, tanks are constructed by welding iron plates to the construction site.

Hopper scale

A hand weigher may replace the hopper scale. Its capacity is 4 t/h. Two-way discharge is requested.

Hammer mill

Raw materials should be crushed smaller than 1 mm in particle size. The mill capacity is 4 t/h.

Mixer

The mixer is a batch of horizontal type with a capacity of 4 t/h.

Pellet mill and pellet cooler

The pellet machine is of the usual type with a capacity of 3 t/h. Two dies of 4 mm and 6mm are needed. A pellet cooler of horizontal type with a capacity of 3 t/h is requested.

Expander machine

An extruder-expander machine of the horizontal type with a capacity of 1 t/h is needed, together with two dies of 4 mm and 6 mm.

Expanded pellet drier

Expanded pellets formed by the machine have a high moisture content of about 30 %, and therefore have to be dried. A box-type electrical drier with a conveyor and blower is desirable. A conveyor speed regulator and temperature control system are needed. The final moisture content of the product should be 12 - 13 %. The desired drying capacity is 1 t/h at 90° C.

Crumbler and sifter

The two machines are needed to work under coverings. A vibration sifter which has two screens of 1 mm and 2 mm mesh is required. A powdery fraction separated is used as mash feed. The capacity of both machines is 500 kg/h.

Packing scale and closing machine

A manual weigher and hand machines may replace both the packing scale and closing machine. If the budget allows, a packer scale for 10 kg and 20 kg and a semi-automatic closing machine with a capacity of 200 bags per hour are needed.

Driers

An ordinary box-type drier with electric heaters and a regulator is needed. The box size is about 8 m x 2 m x 2 m. Three layered conveyors are set inside with a speed regulator. The temperature should also be adjustable. A blower is necessary. The capacity to dry up daily about 10 tons of various raw materials is required. The drier is set up in a drier house annexed to the main plant building.

A direct heating type of fish drier by means of heavy oil burning is needed. The drier is set up on the Mekong River side where electricity is not available. Therefore, no motor is provided. Loading, stirring and unloading of materials are carried out by hand. A daily drying capacity of 20 t of wet fish is required.

Two sets of fast dryers of the direct heating type with a daily capacity of 5 t are needed. The driers are operated as described above.

Most of the equipment needed is of smaller capacity and special orders are necessary to obtain it.

The main equipment requested is listed in table 11 with their capacities and motor powers.

Table 11. List of equipment

Item	Mark	Equipment	Capacity	Motor (hp)
1	HP-1	Hopper		
2	BE-1	Bucket elevator	4 t/h, 13 m	2.0
3	MS	Magnet separator		0.2
4	FC-1	Flow conveyor	4 t/h, 10 m	1.0
5	DS	Distributor		
6	TK-1	Raw material tank	25 t/h, 3 m x 3 x 7 m	
7	TK-2	Raw material tank	25 t/h 3 m x 3 m x 7 m	
8	TK-3	Raw material tank	25 t/h 3 m x 3 m x 7 m	
9	TK-4	Raw material tank	25 t/h 3 m x 3 m x 7 m	
10	HS	Hopper scale	4 t/h	
11	SF-1	Screw feeder	2 t/h, 6 m	1.0
12	SF-2	Screw feeder	2 t/h, 6 m	
13	HM	Hammer mill	4 t/h	10
14	HP-2	Hopper		
15	BE-2	Bucket elevator	4 t/h, 10 m	2
16	MX	Mixer	4 t/h	2
17	FC-2	Flow conveyor	4 t/h, 10 m x 2 m	1
18	ST-1	Service tank	12 t/h, 2 m x 3 m x 5 m	
19	ST-2	Service tank	12 t/h, 2 m x 3 m x 5 m	
20	ST-3	Service tank	12 t/h, 2 m x 3 m x 5 m	
21	SF-3	Screw feeder	3 t/h	1
22	SF-4	Screw feeder	1 t/h	1
23	PM	Pellet machine	3 t/h	30
24	PC	Pellet cooler	3 t/h	5
25	EP	Expander	1 t/h	50
26	DR	Pellet drier	1 t/h	1
27	FC-3	Flow conveyor	3 t/h, 6 m	1
28	FC-4		1 t/h, 4 m	1

Item	Mark	Equipment	Capacity	Motor (hp)
29	PT-1	Product tank	8t, 2 m x 2 m x 5 m	
30	PT-2	Product tank	8t, 2 m x 2 m x 5 m	
31	PT-3	Product tank	8t, 2 m x 2 m x 5 m	
32	PT-4	Product tank	8t, 2 m x 2 m x 5 m	
33	FC-5	Flow conveyor	500 kg/h, 5 m	1
34	FC-6	Flow conveyor	4 t/h, 8 m	1
35	CR	Crumbler	500 kg/h	2
36	SF	Sifter	500 kg/h	2
37	PS	Packer scale	10 kg, 20 kg	
38	CL	Manual closing machine		
39		Drier A	10 t/d	
40		Drier B	20 t/d	
41		Drier C (2)	5 t/d	
42		Electrical boiler	1 t of steam/ 8 h	15
43		A prefabricated cold room (in the raw material store-house)	2 m x 4 m x 2 m (5°C)	
44		Other		
		Water tank and pump		
		Pipes		
		Wires and switch boards		
		Lamps for illumination		
		20 electric fans		
		20 plastic containers of 30 l capacity		
		10 handcarts of 200 kg		
		2 platform scales of 50 kg		
		2 portable moisture meters		

Cost of the fish feed mill establishment

The cost plan was carefully examined to determine the minimum project recuirements. A mutual agreement was obtained on the following three principles for investigating the cost plan:

(a) The establishment of a fish feed mill is urgently needed by Viet Nam;

(b) Intensification of manual labour is inevitable in order to reduce the cost of the plant establishment;

(c) Trash fish drying is necessary to operate the fish feed mill.

The necessary costs calculated were as outlined below.

A. Earthworks, including road constr ıction and water supply work, as estimated by Viet Nam $ 80,000

B. Machines and equipment, including necessary spare parts for two years of normal operation (see also annex) $ 528,000

Equipment and facilities		Estimated cost (dollars)
1.	Electric substation	40,000
2.	Electrical boiler	50,000
3.	Drier A	23,000
4.	Drier B	18,000
5.	Drier C (2 sets)	20,000
6.	Hammer mill	25,000
7.	Hopper scale	22,000
8.	Pellet machine	32,000
9.	Pellet cooler	20,000
10.	Mixer	24,000
11.	Extruder-expander	46,000
12.	Pellet drier	21,000
13.	Crumbler	15,000
14.	Sifter	15,000
15.	Packer scale	10,000
16.	Manual closing machine	6,000
17.	Tanks (11 sets, 420 m^3)	40,000
18.	Elevators, conveyors, motors	20,000
19.	Water tank, pipes	10,000
20.	Wires, switch boards	10,000
21.	Cold room set	22,000
22.	Others	27,000
	Subtotal	528,000

C. Transportation $ 100,000

The rate of $ 150/m^3 Japan-Viet Nam was adopted as an example.

D. Detailed plant design and supervision $ 50,000

E. Machines and equipment installations $ 120,000

Details

1.	Foreign professionals $ 200 x 15 persons x 30 days	$ 90,000
2.	Assisting labours, etc.	$ 20,000
3.	Trial run	$ 10,000

F. House buildings estimated by Viet Nam $ 99,200.

Details		Area (m^2)	Cost (dollars)
1.	Main building	384	$ 57,600
2.	General office	80	12,000
3.	Warehouse	64	6,400
4.	Drier house	84	8,400
5.	Raw material store	64	6,400
6.	Fish drier covering	84	8,400
		Subtotal	99,200

G. Civil engineering works estimated by Viet Nam $ 51,000

H. Vehicles $ 90,000

Details

1.	A bus for 40 persons	$ 50,000
2.	A 2-t light truck	10,000
3.	Two 7-t diesel trucks	30,000
	Subtotal	90,000

I. Diesel engine sets for boats $ 80,000

Details

1.	Two sets of 300 hp engines with shafts and propellers	$ 45,000
2.	Two sets of 250 hp engines with shafts and propellers	35,000
	Subtotal	$ 80,000
	Total	$ 1,198,200

The Government of Viet Nam proposed to cover the following costs:

A.	Earthworks, etc.	$ 80,000
F.	House buildings	99,200
G.	Civil engineering works	51,000
	Subtotal	$ 230,200

An expenditure of $ 968,200 is therefore necessary to carry out the project.

The Vietnamese request for vehicles and boat engine sets is very urgent. The Government wishes to construct boats locally if engine sets are provided. Both the vehicles and boats required to prepare the raw materials, especially for trash fish gathering, drying and transport, are unsatisfactory in Viet Nam. Urgent consideration should therefore be given to the Vietnamese requests.

Energy required to operate the plant

To obtain 2,300 t of dried fish and 1,000 t of dried fermentation by-products needed for the annual production of 10,000 t of artificial fish feed, about 10,000 t of wet trash fish and 5,000 t of wet fermentation residues should be dried to 13 - 14 % moisture content. Usually, 200 l of heavy oil are burned to dry 1 t of such a material to the required moisture content. The plant has an annexed electrical drier capable of drying about 3,000 t of air-dehydrated raw materials annually. Presumably, that is equivalent to 5,000 t of wet raw materials. Therefore, about 10,000 t of wet raw materials are to be dried by the burning of heavy oil. Assuming that 20 % of water in raw materials are removed by pre-dehydration methods such as sun-curing, theoretically 1,600 kiloliters of heavy oil are required to secure the needed raw materials. In fact, more heavy oil will be necessary.

In a full one-shift operation of the plant, a total of 130 h of machine work will consume electric power equivalent to 100 kW/h. The other electric power consumption is not certain.

Manpower required to operate the plant

The number of persons needed to operate the plant varies in a country depending on the custom and system of labour management. Supposing that the plant will be operated under maximum human labour employment, the number of persons needed for a one-shift operation is as follows:

Service	Number of persons required
Administration	12
Production	28
Products management	10
Engineering and maintenance	6
Miscellaneous	4
Total	60

Profitability of artificial feed production

Assuming that an average feed price is 2 D/kg in the plant, the income and expense balance of the plant was calculated as shown in the table 12.

Table 12. Income and expense balance of the plant

Item	Sum (dongs)
A. Income	20,000,000
B. Expenses	13,470,000
Raw material 1/	10,000,000
Production cost 2/	3,000,000
Personnel 3/	150,000
Machinery maintenance 4/	150,000
General management cost 5/	120,000
Miscellaneous expenses 6/	50,000
Profit (B-A)	6,530,000

Note:

1. The average price was assumed to be 1 D/kg
2. Energy cost et. al.
3. Per capita monthly cost is taken as 200 D x 60 (persons) x 12
4. 5% of initial investment to the main plant
5. Rough estimate
6. Rough estimate

It may therefore be concluded that artificial fish feed production is profitable.

Proposed schedule for implementation of the plant project

The following schedule is proposed for implementation of the plant project and a trial run to be finished by the end of April 1982 before the rainy season begins.

January-March 1981	Begin presentation of the detailed plant design and the exact cost estimate to potential plant exporters. The detailed plan should be cleared by the end of March.
April-May 1981	Select the most suitable plant exporter.
June-July 1981	Order machinery, equipment and materials. Draw up a contract with the plant exporter to finish the feed mill construction at Ho Chi Minh City by the end of March 1982. Consider Vietnamese contribution with the Government of Viet Nam. Direct contact between the plant exporter and the Government is very necessary to ensure the success of the programme.
Up to February 1982	Earthworks and all related works should be finished. All ordered equipment, etc. should have arrived at the construction site.
March 1982	The plant should be completed.
April 1982	A trial run will be succeeded by the start of actual artificial fish feed production.

III. CONCLUSION AND RECOMMENDATIONS

Conclusions

1. Available raw materials for artificial fish feed manufacturing are very limited. The materials are mostly obtainable as wet masses. They therefore have to be dried before use as ingredients for artificial fish feed.

2. To obtain fish meal as an important protein component of artificial fish feed, construction of a small fish drying factory is needed at the production site of trash fish. No other usable animal protein sources to replace trash fish were found.

3. The use of boats has an advantage especially for gathering fish and transporting dried fish.

4. Only an extensive fish culture is practicable in Ho Chi Minh City in the present financial situation. The fish production plant will therefore be realizable if the fish feed mill is established.

5. The production of completely artificial fish feed is difficult and unnecessary in Viet Nam. However, practical feed for use in extensive fish culture can be manufactured.

6. To minimize the cost of establishing the fish feed mill, the Government of Viet Nam has proposed to undertake various parts of the project, including earthworks and house construction, employing Vietnamese workers and local materials.

7. The project to establish an artificial fish feed mill at Ho Chi Minh City is feasible. It would involve an additional expenditure of $ 1,000,000.

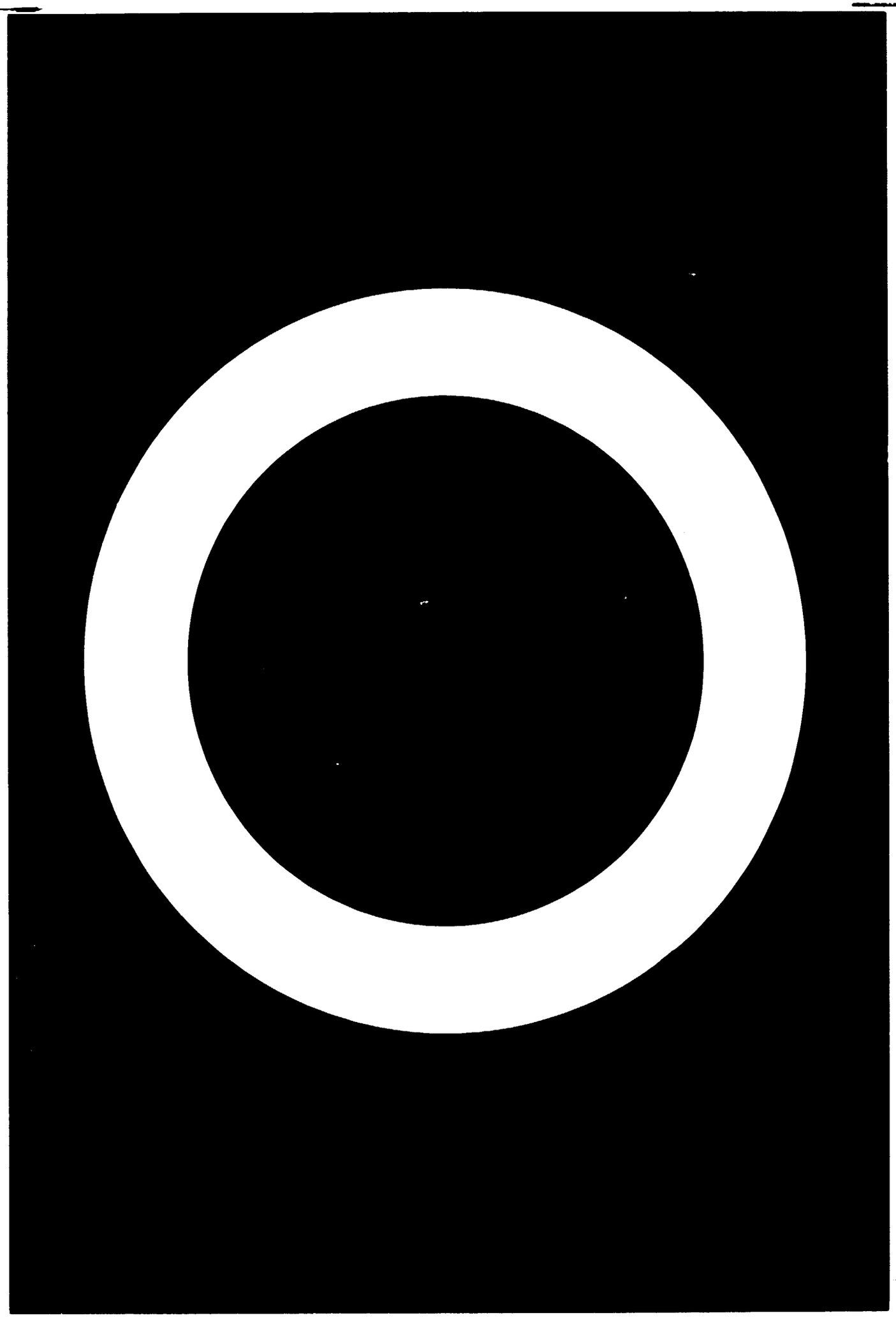
Recommendations

1. The Vietnamese proposal that Viet Nam should assume responsibility for various aspects of the project, such as earthworks and house construction, should be accepted. At the same time, special consideration should be given to Viet Nam for the provision of vehicles and boat engines necessary for the plant operation.

2. When an order for the establishment of the fish feed mill is placed, a plant exporter possessing affiliated plant design and construction engineers should be selected. It would also be useful if the plant exporter has some experience in conducting such a business in Viet Nam. The expert is able to make specific recommendations in this respect, if requested.

3. The Government of Viet Nam should establish a product quality control system as soon as possible. The raw materials and products must at least by analysed and data on protein, fat and ash periodically recorded. The moisture control carried out at the production sites is not sufficient for quality control.

4. In the near future, the establishment of a fish meal factory will become essential to increase feed production of better quality. An investigation of such a project should therefore be undertaken.



Annex

EQUIPMENT COST ESTIMATE

The following cost estimate for the equipment was calculated by Mitsui Co. Ltd. (Japan), FOB, Kobe Port. The estimate was received at the time the report was being reproduced and is valid until the end of April 1981. Minor changes are possible depending on the foreign exchange rates.

Name	Quantity	Prices ($ US)
Crushing and mixing system		150,545
Pelleting and crumbling system		157,370
Expander system		106,315
Packing system		20,110
Electric power station		170,230
Electric boiler system		146,020
Fish drier (20 T/D)	1	68,095
Generator	1	22,700
Small fish drier (5 T/D)	2	105,925
Refrigerator	1	13,160
Spares for 2 years operation		109,700
Material		66,200
Design fee		15,890
Engineers travel cost		128,000
Total		1,280,260

C-300